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THE WORKS OF THE HONOURABLE Robert Boyle, Esq. EPITOMIZ'D.

VOL. II.

BY

RICHARD BOULTON,

of *Brazen-Nose College* in *Oxford.*

Illustrated with COPPER PLATES.

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MDCC.

MVSEVM
BRITAN
NICVM

To His *Excellency* The

Moſt Illuſtrious PRINCE,

CHARLES

Duke of *BOLTON*,

Marquiſs of *Winchester*, Earl of *Wiltſhire*, and Baron St. *John* of *Baſing*; the Premier Marquiſs of *England*; one of the *Lords Juſtices* of the Kingdom of *Ireland*; Lord Lieutenant and *Cuſtos Rotulorum* for the Countys of *Dorſet* and *Southampton*, the Town of *Southampton* and County of the ſame; Vice-Admiral of *Southampton* and the *Iſle* of *Wight*; Lord Warden of the *New Foreſt* in *Hantſhire*, and one of the Lords of His Majeſty's moſt Honourable *Privy-Council*.

May it pleaſe Your Excellency,

SInce nothing contributes more to the Advancement of Natural Knowledge, than the Encouragement of great and eminent Perſons;

ſons, not only Cuſtom but Intereſt hath generally inclined thoſe, who employ their time in the purſuit of it, to ſhelter the Fruits of their Labours under the Protection of noble Patrons: For as there can be no greater Motives to Virtue and Morality, than the Favour of an *Omnipotent* Power; ſo in the Affairs of this World, we are moſt inclin'd to purſue, whatever may deſerve the Eſteem of great Men, or lead us into *their* Favour.

And if the Tree of Knowledge flouriſhes moſt under the favourable Patronage of Princes, the Intereſt of Learning will, at the ſame time, be a good Plea to extenuate my Preſumption, and a great Argument why I ſhould lay this at your *Excellency's* Feet.

For, *Illuſtrious* SIR, whilſt amongſt the happy Number of His Majeſtys *Favourites*,

Favourites, we behold Your Excellency dignified with Titles of Honour, at the ſame time we are ſurprized to ſee, that no Titles can be ſo great but Your Excellency's Character adds a Luſtre to, and increaſes the Dignity of them: A Character! which, could I convey it down to future Ages, I muſt be able to repreſent, in the moſt lively Colours, All the Virtues of a good and pious *Chriſtian*; the meek and liberal Temper of a Puiſſant and Noble *Prince*; the Wiſdom of a *Counſellour*, and the Qualifications of one, to whoſe Judgment and Sagacity the Adminiſtration of the Government of a Kingdom hath been, in a great meaſure, committed, by the moſt Judicious and Sagacious of Kings.

But, *Illuſtrious* SIR, ſince the draught of *ſo Noble* a Character as Your *Excellency's* is too hard a Task for

for a Pen better qualified than mine, I have ſufficient reaſon to decline it; and ſhall rather reflect on the Happineſs of this Kingdom, whilſt ſo Great a *King* hath made choice of ſo Wiſe a *Counſellor*; and the great Felicity of the Commonwealth of Learning, whilſt under the Patronage of ſo Illuſtrious a Prince as the Duke of *BOLTON*; and particularly on my own Happineſs under Your Excellency's Protection, which is the more augmented by this opportunity of profeſſing my ſelf,

Moſt Illuſtrious SIR,

Your Excellency's

Moſt Humble and

Devoted Servant,

Richard Boulton.

THE PREFACE TO THE READER.

THE candid Acceptance of the former Volume, and the favourable Approbation of the Learned, having given the Booksellers sufficient Encouragement to proceed in Printing the two subsequent Volumes; there is no need that I should, on their part, enlarge on the Subject of the Preface annexed to the first Volume, to shew the Usefulness of the Design; since the general Consent of the Learned hath already put that beyond Doubt.

Therefore, having laid down the Reasons why I proceeded in such a Method as I have placed the Subjects in, in the first Volume, in the latter end of that Preface, I shall, without encreasing the bulk of this Volume with a long Preface, briefly subjoyn the Rationale of this; And,

First

First, The first Volume ending with an Epitomy of the Honourable Author's first Continuation of Physico-Mechanical Experiments, *I have begun this with some Experiments belonging to that first Continuation, and to them I have subjoyn'd his second Continuation; to which, by reason of some affinity betwixt particular Experiments that Treatise and another, delivered in another Tract, I have added a Chapter of* Observations on Animals *included in* Vacuo; *and another relating to the same Subject, out of the* Philosophical Transactions: *And because these Observations engage our Thoughts in several things relating to the precedent* Phænomena *of the* Vacuum Boylianum, *and may remind us of what he hath delivered of the* Spring *and* Weight *of the* Air, *I have in the next place laid down his* Animadversions *on Mr.* Hobbes Problemata de Vacuo, *his Discourse of Attraction by Suction, and what he hath deliver'd concerning the* Barometer *in the* Philosophical Transactions. *And forasmuch as in all his* Physico-Mechanical, *and other Experiments already deliver'd, and tryed in* Vacuo Boyliano, *we have several instances of the Rarefaction*

faction and Condensation of the Air, &c. hopeing it would help some to a seasonable Reflection on what was before delivered; I have added what he hath taught concerning the admirable Rarefaction of the Air, and the Duration of its Spring; as also concerning its Condensation and admirable different Extension, when rarified and compressed: And since these Subjects renew our Considerations concerning the Spring of the Air, I have added further, a Chapter of the Weakened Spring of the Air, out of the Philosophical Transactions. And because the Spring and weight of the Air and their Effects, are not the only Qualities and Considerations to be taken notice of in the Atmosphere, from those I proceed to deliver what he hath Taught concerning Hygroscopes and their Utilities; as also what he hath writ of the Efficacy of the Airs Moisture: And because there are several Qualities in the Air which not only affect our outward Senses, but have a manifest Influence on the Mass of Humours which circulate in our Bodies, and on whose Tempers the Preservation or Distempers of a human Body depends, I have added what he hath deliver'd concerning the Salubrity and Insalubrity of the Air, whose variations in Temperature, alter the Constitution

tution of the Humors of our Bodies. And since we are not only affected by manifest Qualities of the Air, but also by occult ones, I have laid down what our Author hath said on that Subject: and since Magnetical and Electrical Qualities are generally accounted Occult ones, I have added his Tracts on those Subjects. And to conclude the Third Book, I have added his General History of the Air, which I have therefore placed the last relating to that Element, because it consists of several Fragments which belong to several of the preceding Subjects, or bear a relation to some others which follow, concerning Colours, Tasts, and Odours. And having thus ended the Third Book, the Fourth contains those Subjects which have a more immediate Relation to the Outward Senses, and are considered as their Objects; which I therefore for distinction sake place together: Of which what our Author hath delivered concerning the Mechanical Production of Tasts, Odours, and Colours, I have laid down in this Volume, and shall proceed to the remaining Objects of our Senses, in the Third Volume; where I shall give a short Account of the Method I take in that, and in the mean time subscribe my self the candid Readers

Very humble Servant,

London, Octob. 13. 1699.

R. Boulton.


Fig: 1. pag. 4.
Fig: 3. pag. 5.
Fig: 4. pag 6.
Fig: 2. pag. 2.




Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.



Vol. II. Plate 3.

Fig. 2. p. 22.

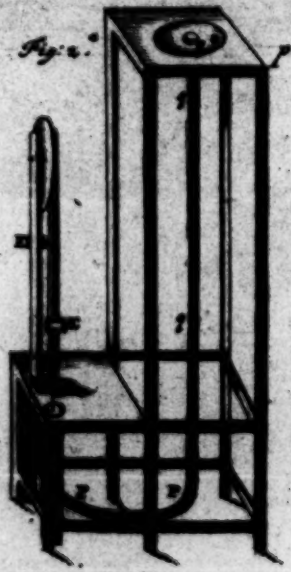
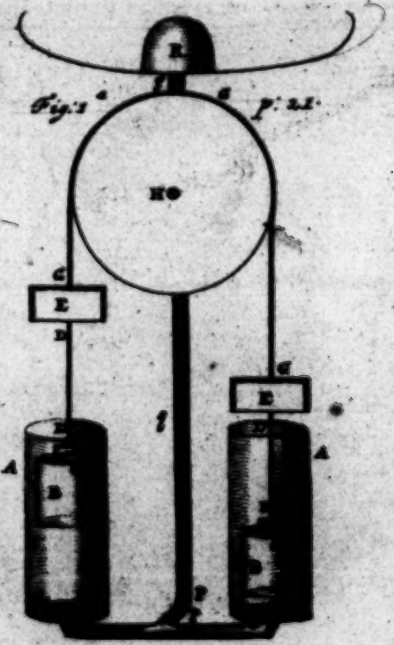
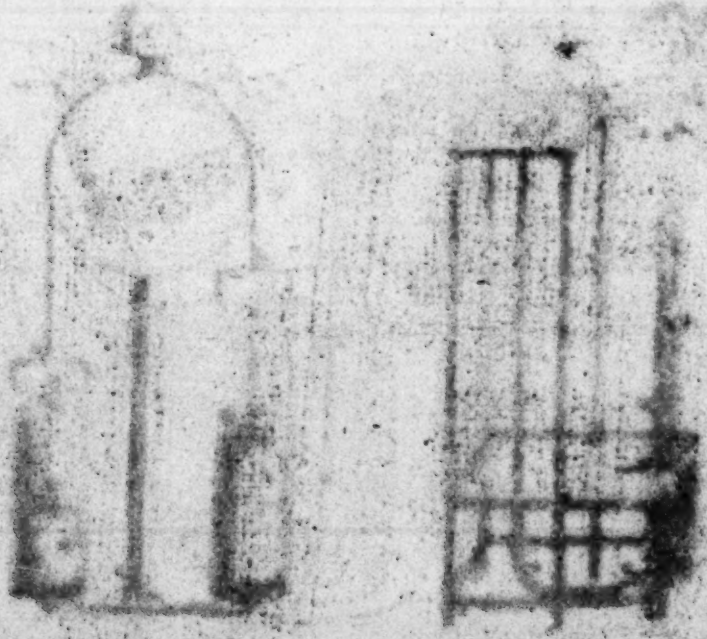
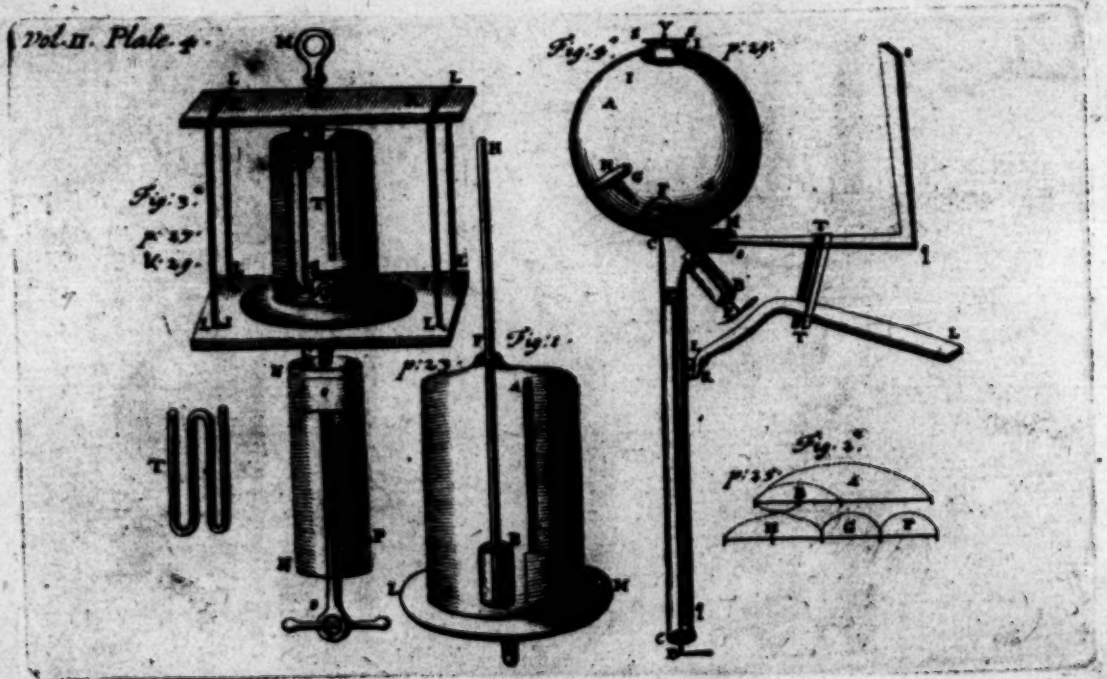


Fig. 1. p. 22.






Vol. II. Plate 4.
Fig: 3.
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Fig: 1.
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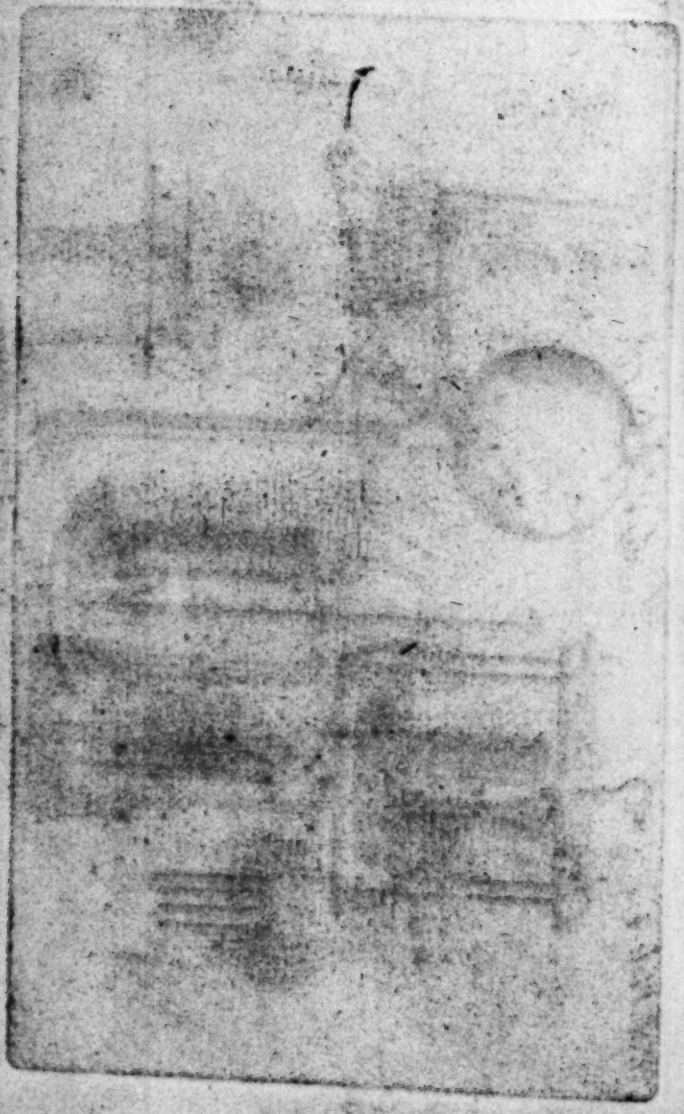
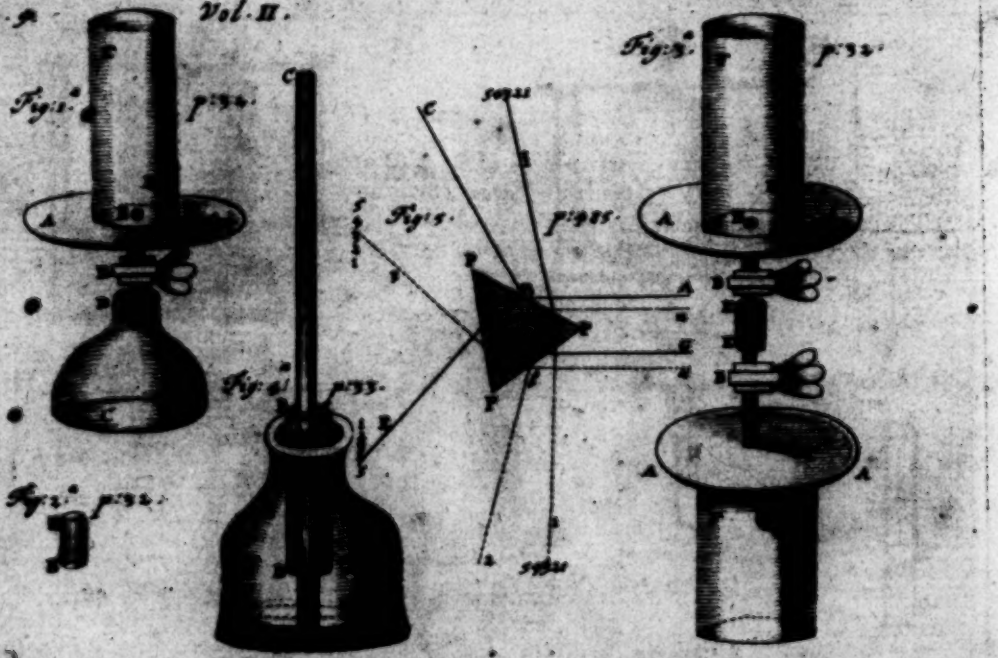


Plate. 9. Vol. II.



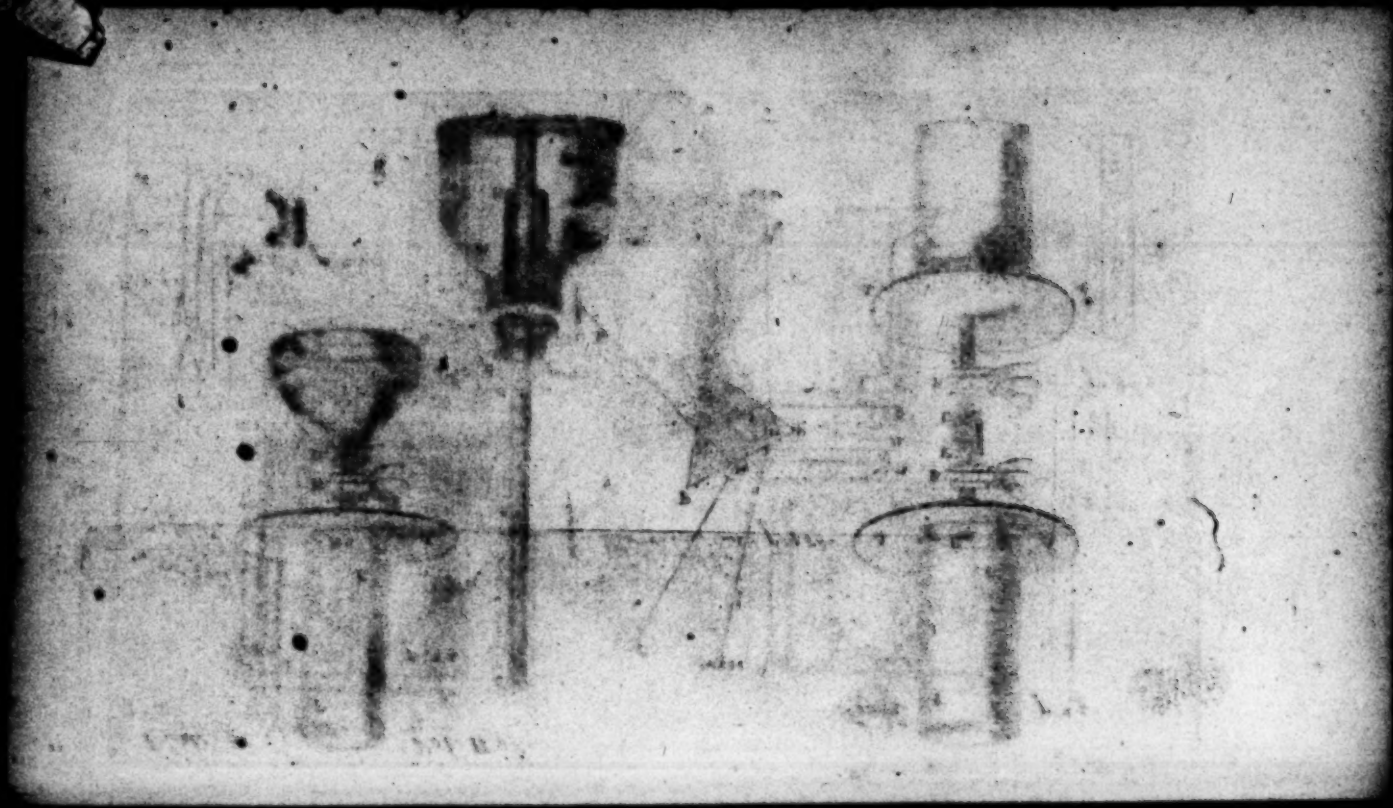
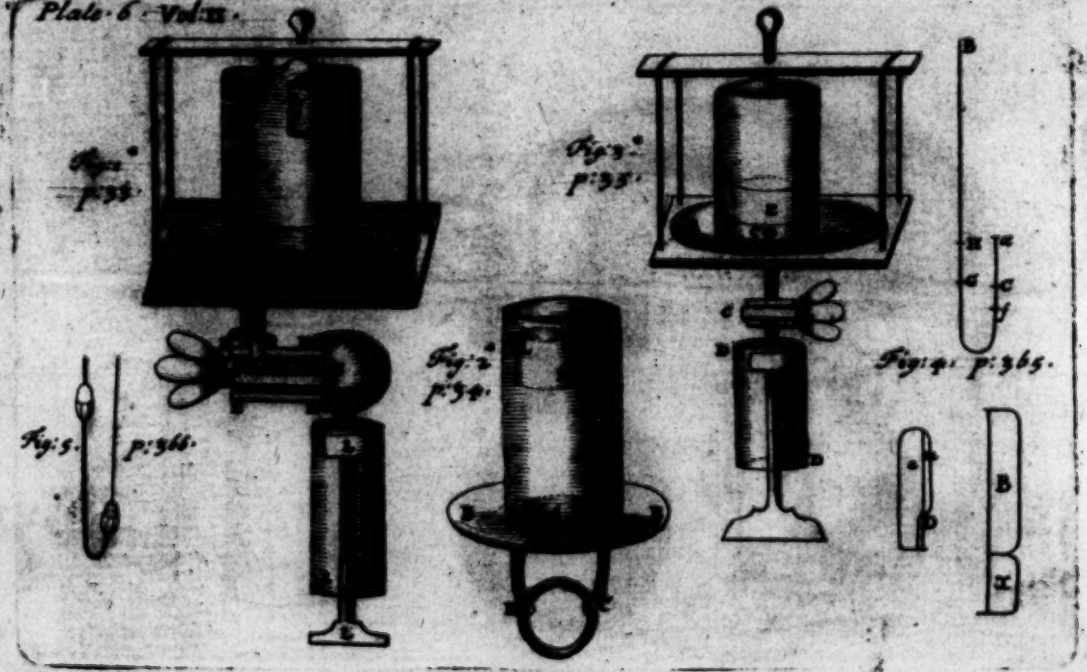


Plate 6. Vol: II.



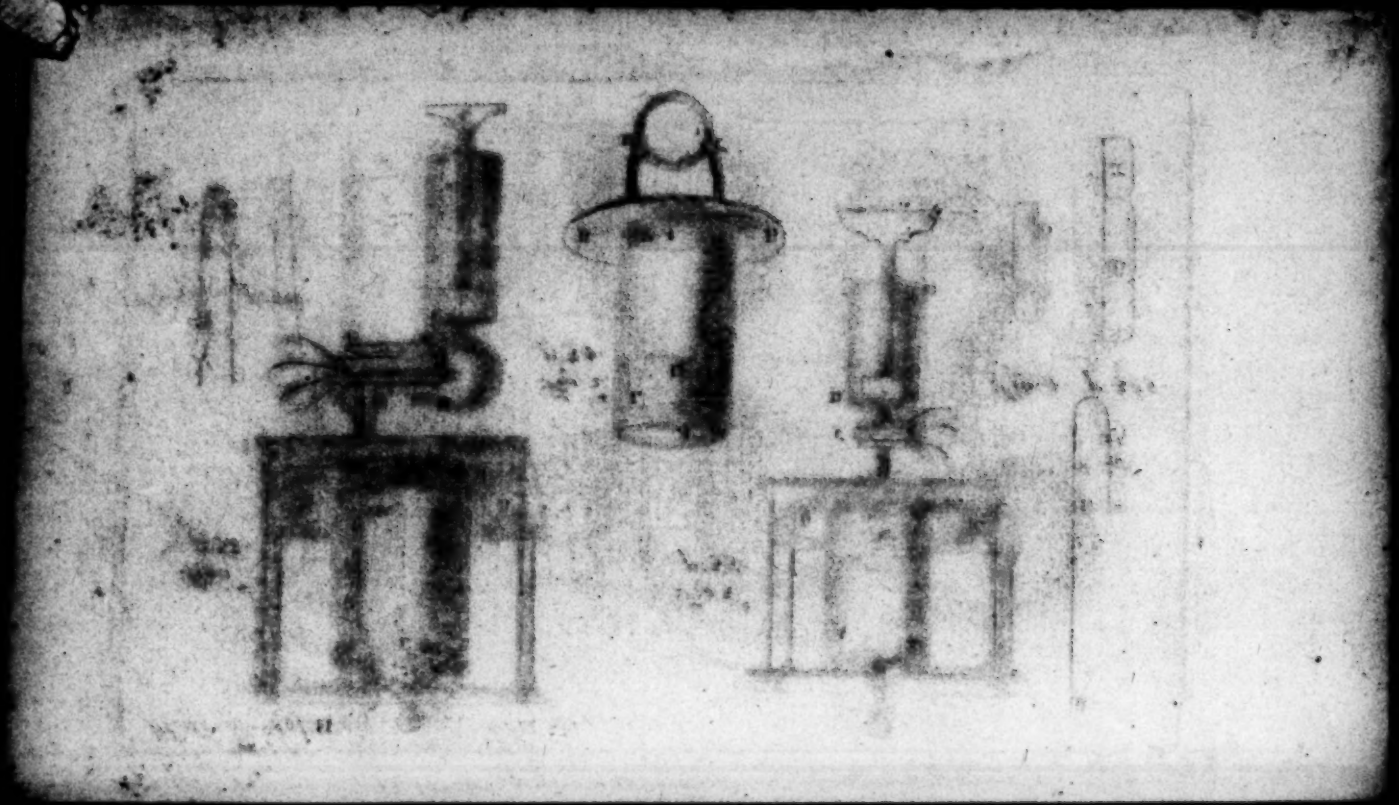
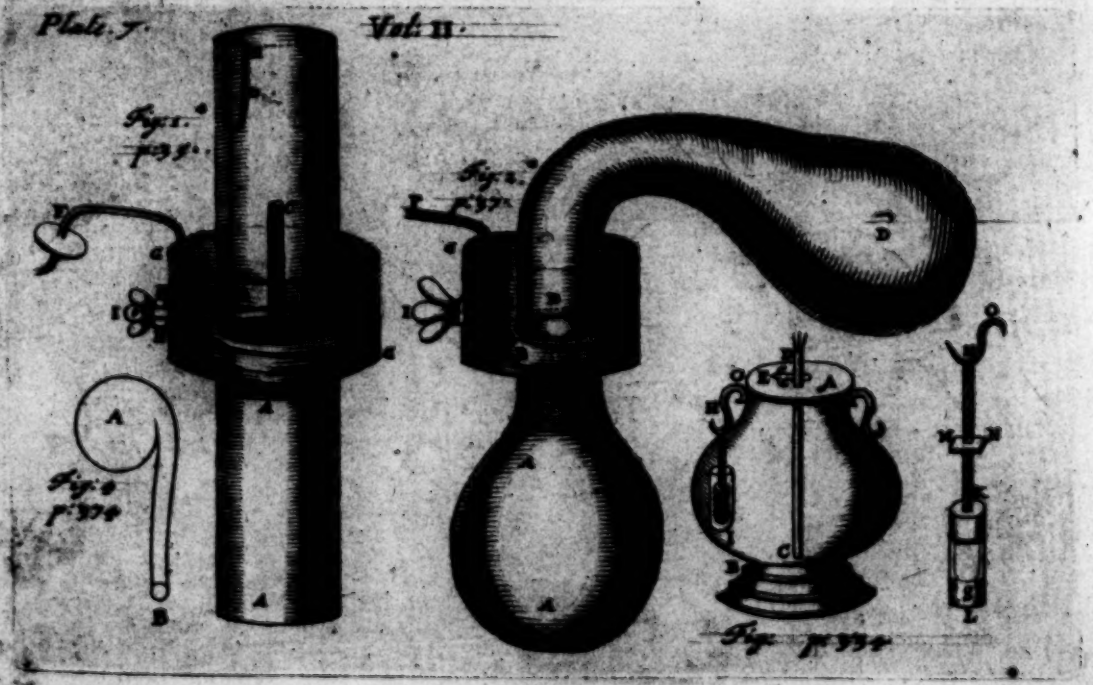


Plate. 7. Vol. II.





THE WORKS

Of the HONOURABLE

ROBERT BOYLE Esq;

EPITOMIZED.

BOOK III.

CHAP. I.

Experiments touching the Spring and Weight of the Air, &c.

THE Bulk of the former Volume, forbidding that I should add any more of the Experiments concerning the Air's Spring and Weight, I shall now proceed to lay down what our Author hath further deliver'd in his first Continuation of Experiments relating to that Subject.

EXPERIMENT I.

The Cauſe of the Aſcenſion of Liquors in Syringes is to be derived from the Preſſure of the Air.

AS in the Experiments recited in the former Volume, it appear'd, that the Preſſure of the External Air, occaſions the Difficulty of drawing up the Sucker of a Syringe; ſo I ſhall now ſhew, that the Preſſure of the External Air, upon the Surface of the Water, in which the Syringe is immerſed, cauſes it to aſcend, when the Sucker is drawn up.

TRYAL I.

Having cemented a Glaſs Pipe to the lower End of a Syringe, and immerſed the lower End of that Pipe in a Viol which contain'd Mercury, we tyed the Sucker of the Syringe to the Stopple which is in the Cover of the Receiver, and having conveighed it into ſuch a Receiver as *Fig.* 2. *Plate* 1. Repreſents; we obſerv'd, that upon drawing up the Sucker, the Mercury did not in the leaſt aſcend, till the Air was let into it, and then it aſcended up to the Top of the Glaſs Tube: And this Experiment being varied, by drawing the Sucker up an Inch before the Receiver was exhauſted, the Mercury roſe to the Top of the Glaſs Tube, tho' it did not in the leaſt riſe when the Sucker was drawn up as high again, after the Receiver was exhauſted. And in trying this Experiment it was further to be noted, that when the Receiver was exhauſted, it

See Plate 1. Fig. 2.

it was as difficult to raiſe the Sucker, as when the End of the Syringe was ſtopped, the remaining Air which was able to keep the Sucker from riſing, being unable to raiſe the Mercury.

TRYAL II.

Being a Proſecution of the former.

The former Tryal being again repeated, beſides what we obſerved in that Experiment, we further noted, that a conſiderable Weight being tyed to the Syringe to keep it ſteady and firm, the Mercury did not riſe till we permitted the Air to return again into the Receiver, tho' the Sucker was raiſed two Inches.

But leſt the *Phænomena* exhibited by theſe Experiments, ſhould be influenced by the Air contain'd in the Glaſs Pipe; I caus'd the Pipe to be fill'd with Spirit of Wine, and immerſed it in a Viol which contain'd the ſame Liquor tinged with Cocheneel; and obſerv'd, that tho', when the Receiver was exhauſted, the Liquor afforded Bubbles plentifully, and at the Top ſeemed to boyl, yet it did not aſcend in the leaſt, notwithſtanding the Sucker was raiſed two Inches and a half: But when the Air was let into the Receiver again, it aſcended into the Body of the Syringe, which appeared, by the ſmall Quantity of Spirit remaining in the Bottle, in which the Glaſs Tube was immerſed.

EXPERIMENT II.

An Attempt to diſcover the Motion of Æther *in the Exhauſted Receiver.*

See Plate 1. Fig. 1.

HAving inſtead of the Glaſs Tube mention'd in the former Experiment, provided a crooked one of Braſs, ſuch as the firſt *Figure* repreſents, and joyn'd a Glaſs Tube to the ſhorter Leg with Cement, we caus'd Weights to be fixed to the Top of the Sucker to depreſs it ſpeedily when occaſion required: This Syringe was fixed to a Pedeſtal to keep it firm, and to hinder it from tottering; and a Feather was likewiſe fixed with Cement to the lower End of the Syringe, ſo that the ſmall End was placed above the Orifice of the crooked Tube. All which being conveyed into a Receiver, and the Pump ſet on Work, we obſerv'd, that, the Sucker by the help of the Turning-Key being often elevated and permitted to fall again, the Feather was gradually leſs ſhaken, with what was forced out of the Syringe, as the Receiver was more and more exhauſted, till at the laſt the Feather did not ſeem in the leaſt to be moved, before Air was again let in, and then it was blown up as before: In which Experiment we obſerv'd, that as the Cavity of the Receiver was more or leſs exhauſted, the Deſcent of the Sucker was accordingly quickened, ſo that had there been a Subſtance finer than Air in the Receiver, the Blaſt would have been greater as the Deſcent of the Sucker was ſwifter.

We

We tryed the ſame Experiment a ſecond time, contriving to draw up the Sucker higher than we did before, but the Event was no more ſatisfactory than the former.

But that I might be informed, what Quantity of Air was drawn out every Exſuction, as well as when the Feather was more or leſs ſhaken by the Wind thrown out of the Syringe, I made uſe of a Glaſs Tube, ſuch as *Figure* the Third repreſents, inſtead of the former Brazen One; and the one End being immerſed in a Jar, and placed in the Receiver, as the Air was pumped out, ſeveral Bubbles broke through the Water out of the Pipe, but External Air getting in at a Leak, the Water was preſſed up into the Pipe again; nevertheleſs, upon an Exſuction of that Air it again ſubſided; yet yielded ſo many Bubbles, that we could not conveniently make any further Obſervations, till the Receiver having ſtood ſtill for ſome time, the Water was freed from Air; and then, tho' the Pump was ſet on Work, till the Gage diſcovered the Receiver to be very well exhauſted; yet we could not diſcern, that any Bubbles were forced through the Water in the Bottom of the Tube by frequently elevating and depreſſing the Sucker; for tho' there appear'd a few in the Top of the Water, yet we judged that thoſe rather proceeded from ſome aery Particles lodging in the Pores of the Water. *See Plate 1. Fig. 3.*

But what was moſt Remarkable in this Experiment was, that after ſome time the Water riſing about an Inch in the Tube, above the Surface of the Water without it, we ſeveral times rais'd the Sucker 2 or 3 Inches, and ſuffered it

to fall again, without perceiving, that the Water in the Tube was in the leaſt Affected; which is an Argument either of a *Vacuum*, or that the Parts of that *Æther* are ſo fine, that they exceed the Rarefaction of the Air ſo far, as not to be able to effect what a Particle of Air does which is not above $\frac{1}{300}$ part of the Quantity of a Pin's head; a Particle of Air, before Expanſion, of that Minuteneſs being able, when the Receiver is exhauſted, to diſplace much more Water upon their Expanſion than this *Æther*.

By which Experiment, as well as what we have taken notice of, the Reaſon I formerly aſſign'd for the riſing of Water in Syphons ſeems to be confirm'd; the Water in the Pipe made uſe of in theſe Experiments, not being able to riſe when the Air was exhauſted, tho' the Sucker was drawn up, till Air was permitted to enter into the Receiver again.

EXPERIMENT III.

Concerning the falling of a light Body in the Exhauſted Receiver, the Figure of it diſpoſing it's Motion to be viſibly alter'd by a ſmall Reſiſtance of the Air.

TO diſcover whether ſo light Bodies as Feathers would be affected in their deſcent in the exhauſted Receiver by any ſubtle Matter contain'd in it, we fix'd a ſmall pair of Tobacco-Tongs in ſuch a Receiver as *Fig.* the Fourth Repreſents, which was 22 Inches high, and having joyn'd four Feathers together with Cement, ſo

See Plate 1. *Fig.* 4.

ſo as to lie acroſs each other, we fixed a ſmall piece of Paper to them, which being held in the Tongs, the Feathers hung in an horizontal Poſture; And upon an Exſuction of the Air out of the Receiver, till by a Mercurial Gage it ſeem'd void of Air, we open'd the Tongs, by turning the Stopple in the Cover of the Receiver, (a ſhort String, the one End of which was fixed to the Stopple, and the other to the Tongs, being by that means ſhortned) upon which we obſerv'd, that tho' theſe Feathers turned ſeveral times in the unexhauſted Receiver, yet the Experiment being often repeated, we could not perceive them in the leaſt to turn in the exhauſted Receiver, but to fall like a dead Weight; and what was further to be obſerved was, that the Deſcent of the Feathers was much quicker in the exhauſted Receiver, than when it was full of Air.

Yet in this Experiment it was obſerved, that the *Phænomena* were leſs convincing than the former, becauſe we took notice that the Feathers fell without in the leaſt turning when the Receiver was but half exhauſted.

And we further noted in this Experiment, that, the Receiver being lengthened with a Cylinder of *Laton*, cover'd over with Cement, and kept from being preſs'd too much inward by the outward Air, by a Caſe made of Iron Bars, when the Air was let in again into the exhauſted Receiver, it made a conſiderable crackling Noiſe, the ſides of the Metalline Receiver which before were in ſome meaſure compreſs'd being again extended.

EXPERIMENT IV.

Of the Propagation of Sounds in the Exhauſted Receiver.

See Plate 2. Fig. 1.

HAVING cauſed a Cylinder of Box to be turned, with an Axle-tree at each End, into the Cavity of the uppermoſt was received the Bottom of the Stopple; and the Axle-tree at the Bottom was adapted to a Hoop of Braſs fixed in the middle of a Trencher, which was about 5 Inches broad, and 3 thick, and which had a piece of Lead fixed to the Bottom to keep it ſteady; which being done, a Wyer was fixed in the upper part of the Trencher, and at the End, which bent downwards, was fixed a Bell, and at another place of the ſame Trencher was fixed a Steel Spring, to the upper part of which a piece of Steel was joyn'd, at ſuch a convenient Diſtance, that when it was bent back by two Pegs placed at right Angles in the Cylinder (which had ſeveral Holes made in it on purpoſe) and the Spring on a ſudden ceaſed to be preſſed upon, it would fly forcibly upon the Bell, and give it a ſmart Stroak.

Things being thus ordered, I cauſed the Receiver to be exhauſted, and tho' the Sound (which was caus'd by turning the Cylinder fixed to the Stop-Cock, ſo as to make the piece of Steel ſtrike upon the Bell) was ſcarce diſcernible, yet as Air was gradually let in, it became louder and more audible.

And

And the like Experiment being tryed by ſuſpending a Watch which had an Alarum belonging to it, by a piece of Thred, which was tyed to a Glaſs Button purpoſely blown in the inſide of a Receiver which was made of one entire piece, ſo that it was leſs ſubject to break; we ordered the Watch ſo, that the Alarum ſhould begin to go by the time that we were ready to make our Obſervations, at which time one that held his Ear near enough to the Top of the Receiver, perceiv'd, that when the Air was wholly exhauſted, the Sound of the Alarum was ſcarce at all diſcernible, but became much louder as the Air was gradually let in.

EXPERIMENT V.

About the breaking of a Glaſs Drop in the Exhauſted Receiver.

TO know the Reaſon, why upon the Breaking of a Part of the ſolid Caſe of the Stem of a Glaſs Drop, which upon it's firſt Formation falling into Water, was kept full of Rarifi'd Air; I ſay, to know the Reaſon, why ſuch a Bottle flies in pieces when part of the Stem is broken off upon a ſudden Ingreſs of External Air; I cauſed the lower End of a Glaſs Drop to be faſtened to a ſtaple Body, the Stem being tyed to one End of a String, and the other End being faſtened to the Turn-Key; which being done, and the Receiver exhauſted, the Stem was broke off by ſhortning the String, whereupon the Bubble flew into

into a Thouſand Pieces, the Air incloſed expanding violently, and endeavouring to ruſh out at that ſmall Vent.

EXPERIMENT VI.

About the Production of Light in the Exhauſted Receiver.

TO try whether Light might be produced in the Exhauſted Receiver without an Acceſs of Air, we made uſe of a Virtical Cylinder, the lower *Baſis* of which was fixed in a Staple Trencher; and having fixed two pieces of Steel in the lower End of that Cylinder, ſo as to rub forcibly againſt a Lump of Loaf-Sugar, I obſerv'd, that the Vitriol Cylinder being forcibly turn'd by the help of the Turning Key, the Steel made Impreſſions ſtrong enough upon the Sugar, to cauſe it to afford, not only ſeveral Flaſhes, but little Sparks of fire.

EXPERIMENT VII.

The Production of a kind of Halo, and ſeveral Colours in the Exhauſted Receiver.

WE made uſe of a large inverted Cucurbite for a Receiver, which being exhauſted, and a large Candle held on the Oppoſite ſide, when the Stop-cock was turned, to give way for the Air, to paſs out of the Receiver into the Cylinder, the Cavity of the Cylinder ſeemed to be filled with Fumes; ſo that the Candle whoſe Flame was viſible, though it appeared to be encom-

compaſſed with a kind of Halo, whoſe Colour was between Blew and Green; and after a few Exſuctions, would be of a Reddiſh or Orange Colour, very vivid: Which Meteor I ſuppoſed to ariſe, from ſome Particles of the Turpentine, which extricating themſelves upon the Application of a hot Iron to the Cement, cauſed an Exploſion in the Receiver, when the Parts of the Air were put in Motion and diſpoſed to Expanſion; and the variety of Colours, I conceive to proceed from the various Poſitions of thoſe Particles of Matter which fill up the Receiver and variouſly reflect the Rays of Light. To confirm which Opinion I obſerved ſeveral Steams to riſe up from the Cement upon turning of the Stop-cock; and if we continued to exhauſt the Receiver, it would become clearer and clearer, and the Colours more dilute, till the Cement was enabled to emit more Steams, by re-applying a hot Iron to it: And as for the Reaſon, why theſe Steams do not ſo plentifully riſe, when the Receiver is evacuated, it appears to be, becauſe the Particles of the Turpentine are leſs agitated as the Heat declines; and further, becauſe they want Air to ſupport them.

To confirm what I have intimated, as the Cauſes of the aforementioned *Phænomena*, I conveyed ſome of the Cement Melted in a Crucible into a Receiver; and obſerved, that upon opening of the Stop-cock to let out the Air, the Steams would for ſome time plentifully fly about, but after a little time would ſubſide again. But in the aforementioned *Phænomena*, the ſeveral Colours ſeemed to depend on the different Degrees of Heat which the Cement acquired; as alſo

alſo, on the different Size and Figure of the Receiver; as alſo, on the Nature of the Cement and the Quantity of Air which was left unpumped out.

EXPERIMENT VIII.

About the ſlacking of Quick-lime in the Exhauſted Receiver.

HAving conveyed an Evaporating Glaſs, with a ſufficient Quantity of Water in it into the Receiver, when the Air was drawn out, we let down a piece of unſlacked Lime into it, by the Aſſiſtance of the Turning-Key; and obſerv'd, that in about ¼ part of an Hour, the Lime began to ſlack violently, and at each Exſuction afforded very large Bubbles, which continued as long as we plyed the Pump; ſo that in a little time the whole inſide of the Receiver was cover'd over with Lime Water, a great part of the Mixture boiling over into the Capacity of the Receiver; in which Experiment the Outſide of the Veſſel was conſiderably hot, and the Mixture continued its Heat near ¼ part of an Hour after the Receiver was removed: The Lime made uſe of in this Experiment was very ſtrong.

EXPE-

EXPERIMENT IX.

An attempt to meaſure the force of the Spring of included Air, and examine a Conjecture about the difference of it's ſtrength in unequally broad-mouthed Glaſſes.

TO meaſure the force of the Air's Expanſion, we fixed a Syringe in a Frame, that it might be kept firm and erect; which being done, we provided a Leaden Hoop, which was ſuſpended at the Top of the Sucker, and hung ſo far below the Bottom of the Syringe, that it might have Space enough to riſe in upon the Expanſion of the Air in the Cavity of the Syringe, when the Receiver ſhould be exhauſted; the Weight in the mean time being prevented from compreſſing the Air beyond it's natural State by a String, the one end of which was tyed to the Top of the Sucker, and the other to the Turning Key; which being done, and the Pump ſet on Work, we found, that the Expanding Air was able to raiſe about 7 or 8 pound Weight, and had the Rammer had a free Paſſage it probably would have raiſed a much greater Weight; but the Experiment was leſs ſatisfactory in determining the force of the Air's Expanſion, in elevating a determinate Weight; becauſe the Air made it's way too eaſily betwixt the convex Superficies of the Sucker, and the concave Surface of the Cylinder.

Therefore to be more exact, I cauſed two Cylinders to be made different both in Length and Breadth, the Diameter of the one being an Inch, and

and of the other two Inches; In the former, I put a Lamb's Bladder, which contained a ſufficient Quantity of Air, and having ordered the Receiver to be exhauſted, I found, that a Cylinder of Air of an Inch Diameter, was able to raiſe a Weight of 10 Pound *Averdupoiz* Weights; but tho' the Bladder for a long time kept the Air from flying away, yet when it was loaded with the utmoſt Weight it was able to bear, ſome Air getting out of the Bladder rendred our Tryal leſs ſatisfactory.

Wherefore we made uſe of a Cylinder 4 Inches Deep and two in Diameter, which having a broad Baſis to ſtand upon, we put a Lamb's Bladder into it well blown and tyed; and putting a Wooden Plug upon that, we loaded the Plugs with Weights amounting to 35 Pound, the uppermoſt of which was faſtned to the Turning-Key, to prevent it from falling, and then the Plug being marked at the brim of the Cylinder, we ſet the Pump on Work, and obſerved that the Expanſive force of the Air in the Bladder was ſo great that it lifted up the Plug conſiderably; yet when the Air was again let into the Receiver the Plug was ſo far depreſſed that the Mark was below the Edges of the Receiver; yet the Air being again a ſecond time exhauſted, the Bladder raiſed the Plug ſo high, that ⅓ parts of the whole Plug was lifted up above the Edges of the Cylinder. And by repeating the Tryal we found, that the Air in the Bladder, when the Receiver was exhauſted, was able to bear up 7 pound Weight more, by which Weight the Mark upon the Plug, was not depreſſed below the top of the Cylinder.

See Plate 2. Fig. the 2 and 4.

But

But in trying theſe Experiments the following Particulars are to be Noted.

1. That the Plug muſt be ſo adapted to the Cylinder as to move up and down eaſily; alſo it muſt be of a convenient length, not exceeding an Inch and a half; and it will be likewiſe requiſite that the Plug ſhould have a ſtrong Ledge upon the upper part of the Cylindrical Surface, that it may reſt upon the Edges of the Cylinder and ſuſtain the Weights laid upon it more firmly.

2. When the Bladder was put into the hollow Cylinder, we took care to adapt it by eaſie and frequent Compreſſions to the Cavity it was placed in, making a Mark in the inſide of the Cylinder where the Air in it's Natural State was Compreſſed to, that we might learn what Weight the Expanſion of the Air was able to ſuſtain above that Mark; for the Air being preternaturally compreſſed, upon the Account of that accidental preſſure may be able to raiſe a greater Weight than Air uncompreſſed, ſo that the Weight it raiſes above that Mark is alone to be taken for what Air condenſed is able to lift up more than the Air in it's Natural State.

3. When the Bladder was taken out of the Cylinder, the Figure of it was proportionable to the Cavity, which it was contained in, being 2 Inches Diameter, and 2 Inches and $\frac{1}{2}$ long.

4. From the Experiments now mentioned it appears, that the Air is able at it's firſt Expanſion, to raiſe a Weight proportionably larger according to the different Bores of the Cylinders made

made uſe of; but when it hath been a little more Expanded the Proportion is not ſo exact, becauſe a ſmall Quantity of Air being to fill up $\frac{1}{4}$ or $\frac{1}{5}$ part of an Inch more, the ſmaller Quantity of Air muſt be much more rarified and conſequently loſe of it's expanſive Force.

But comparing the expanſive Force of Air in different Bores at it's firſt Expanſion, ſome may think the Proportion not exact; ſince the ſmall Bladder being able to raiſe no more but 10 Pound, and the Weight which the larger raiſes being 42, it is more than a Duplicate Proportion of what our Hypotheſis requires; but if we conſider that comparing the Diameter of each Cylinder, the Bladder in the leſs, proportionably takes up more Room than in the larger; it may be ſufficient to account for the Difference.

5. Conſidering that the Bladders in which Air is Included, may ſtraiten the Cavities of the Cylinders, the expanſive Force of the Air might be more exactly determined, could Cylinders be contrived ſtanch enough without ſuch helps.

6. And it will not a little contribute to render the Force of the Air's Spring difficult to be determined, that the Air it ſelf at different times varies, in it's degrees of Preſſure: Yet from what hath been ſaid it ſeems probable, that were it poſſible to contrive an exact Cylinder very tite one, of an Inch Bore would be able to raiſe above 10 pound Weight.

EXPE-

EXPERIMENT X.

An eaſie way of making a ſmall Quantity of Included Air raiſe 50 or 60 Pound or a greater Weight in the Exhauſted Receiver.

TO demonſtrate more obviouſly the Air's Spring, we took a * Braſs Cylinder whoſe Depth was 4 Inches and it's Diameter 4 Ineches and ¾, to which we adapted a †† ſhort Plug, to whoſe upper Baſis was fixed a broad Rim for Weights to ſtand on more firmly; which being done we preſſed a Bladder into the Cylinder, that it might adapt it ſelf to the Cavity of it; and then, obſerving, how much the Plug was above the ſurface of the Cylinder, we laid the Weights upon it (ſee *Plate* the 2d *Figure* the 5*th*) and obſerved that the Air in a Cylinder about 4 Inches broad lifted up 75 pound at the 5 Exſuction ſo high that one might diſcern the Mark; and at 2 Exſuctions more it was elevated ⅛ above the Top of the Cylinder, and at the ſame time, in a Mercurial Gage the Mercury that uſually ſtood at ¼ above the higheſt Glaſs Mark ſubſided to ¼ below the Second. When the Air was let into the Receiver again, after ſome time the Bladder ſubſided again, and being taken out exactly anſwered the Cavity of the Cylinder. The Receiver being again exhauſted at the 24th Exſuction the Mercury in the Gage was depreſſed to the loweſt Mark, and at the 35th to ¼ below it.

* See Plate the ſecond Fig. 4.
†† See Plate 2. Fig. 5.

And the former Experiment being tryed in a ſmall Receiver in which we heaped flat Weights one upon another, the Air raiſed 100 pound

Weight, and would probably have raiſed much more, had it not been, that the Bladder was ſo much ſtrained as to give way for ſome Air to get out at a Leak.

And here it may not be improper to advertiſe, that the Orifices of ſuch Receivers muſt not be very wide, for if they be they will be ſubject to be crack'd by the violent external Preſſure of the Atmoſphere.

EXPERIMENT XI.

TO Compare the Gravity of Air and Water, I weighed a Glaſs Bubble in the Receiver, which I found to weigh above half a Grain more in the exhauſted Receiver than before the Air was drawn out; and this Bubble being weighed in the open Air counterpoiſed 68 Grains and an half; upon which the Bubble

of Steel in the lower End of that Cylinder, ſo as to rub forcibly againſt a Lump of Loaf-Sugar, I obſerv'd, that the Vitriol Cylinder being forcibly turn'd by the help of the Turning Key, the Steel made Impreſſions ſtrong enough upon the Sugar, to cauſe it to afford, not only ſeveral Flaſhes, but little Sparks of fire.

EXPERIMENT VII.

The Production of a kind of Halo, and ſeveral Colours in the Exhauſted Receiver.

WE made uſe of a large inverted Cucurbite for a Receiver, which being exhauſted, and a large Candle held on the Oppoſite ſide, when the Stop-cock was turned, to give way for the Air, to paſs out of the Receiver into the Cylinder, the Cavity of the Cylinder ſeemed to be filled with Fumes; ſo that the Candle whoſe Flame was viſible, though it appeared to be en-

com-

which Experiment the Proportion of Air to Water in Weight was as 857 ½ to one. But *Galileo* ſays, Water is but 400 times heavier than Water, tho' *Riccioli*us is as much miſtaken on the other ſide, who ſays it is 10000 times heavier.

To inform my ſelf further of the Weight of the Air, I took the following Meaſures; having exhauſted a Receiver, and when it was void of Air counterballanced it, upon turning the Stop-Cock and a Reingreſs of Air, it weighed 36 Grains more than before, which ſucceeded when tryed a ſecond time, and likewiſe a third. And then the Receiver being exhauſted was immerſed in Water, and the Stop-Cock turn'd to give way to an Ingreſs of Water, and when as much Water as was able to enter into the Receiver had ſucceeded in the Place of the exhauſted Air, we turned the Cock again to keep that Water up from the Cement upon turning of the Stop-cock; and if we continued to exhauſt the Receiver, it would become clearer and clearer, and the Colours more dilute, till the Cement was enabled to emit more Steams, by re-applying a hot Iron to it: And as for the Reaſon, why theſe Steams do not ſo plentifully riſe, when the Receiver is evacuated, it appears to be, becauſe the Particles of the Turpentine are leſs agitated as the Heat declines; and further, becauſe they want Air to ſupport them.

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Therefore to be more exact, I cauſed two Cylinders to be made different both in Length and Breadth, the Diameter of the one being an Inch, and

and of the other two Inches; In the former, I put a Lamb's Bladder, which contained a ſufficient Quantity of Air, and having ordered the Receiver to be exhauſted, I found, that a Cylinder of Air of an Inch Diameter, was able to raiſe a Weight of 10 Pound *Averdupoiz* Weights; but tho' the Bladder for a long time kept the Air from flying away, yet when it was loaded with the utmoſt Weight it was able to bear, ſome Air getting out of the Bladder rendred our Tryal leſs ſatisfactory.

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But in trying theſe Experiments the following Particulars are to be Noted.

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3. When the Bladder was taken out of the Cylinder, the Figure of it was proportionable to the Cavity, which it was contained in, being 2 Inches Diameter, and 2 Inches and ½ long.

4. From the Experiments now mentioned it appears, that the Air is able at it's firſt Expanſion, to raiſe a Weight proportionably larger according to the different Bores of the Cylinders made

made uſe of; but when it hath been a little more Expanded the Proportion is not ſo exact, becauſe a ſmall Quantity of Air being to fill up ¼ or ⅓ part of an Inch more, the ſmaller Quantity of Air muſt be much more rarified and conſequently loſe of it's expanſive Force.

But comparing the expanſive Force of Air in different Bores at it's firſt Expanſion, ſome may think the Proportion not exact; ſince the ſmall Bladder being able to raiſe no more but 10 Pound, and the Weight which the larger raiſes being 42, it is more than a Duplicate Proportion of what our Hypotheſis requires; but if we conſider that comparing the Diameter of each Cylinder, the Bladder in the leſs, proportionably takes up more Room than in the larger; it may be ſufficient to account for the Difference.

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And the former Experiment being tryed in a ſmall Receiver in which we heaped flat Weights one upon another, the Air raiſed 100 pound

Weight, and would probably have raiſed much more, had it not been, that the Bladder was ſo much ſtrained as to give way for ſome Air to get out at a Leak.

And here it may not be improper to adverti ſe, that the Orifices of ſuch Receivers muſt not be very wide, for if they be they will be ſubject to be crack'd by the violent external Preſſure of the Atmoſphere.

EXPERIMENT XI.

TO Compare the Gravity of Air and Water, I weighed a Glaſs Bubble in the Receiver, which I found to weigh above half a Grain more in the exhauſted Receiver than before the Air was drawn out; and this Bubble being weighed in the open Air counterpoiſed 68 Grains and an half; upon which the Bubble being immerſed in Water, we found that the Air in it had been ſo far rarified by the Heat employed in ſealing it up, that the Nip being broke off, it ſucked in 125 Grains of Water, the Glaſs together with the Water ſucked into it weighing 193¼ Grains: The whole Cavity of the Bubble being large enough to contain 739 Grains of Water, it weighing 807¼ Grains, ſo that the Proportion betwixt the Weight of the Air and Water did not quite amount to 1228 to 1.

Having weighed a Glaſs Bubble in the Receiver, whoſe Weight was 60 Grains, the Air contained in it *in Vacuo* weighed $\frac{3}{10}$ of a Grain, and the Weight of ſuch a Quantity of Water as it would contain, weighed 720¼ Grains. In which

which Experiment the Proportion of Air to Water in Weight was as 857 ½ to one. But *Galileo* ſays, Water is but 400 times heavier than Water, tho' *Riccioius* is as much miſtaken on the other ſide, who ſays it is 10000 times heavier.

To inform my ſelf further of the Weight of the Air, I took the following Meaſures; having exhauſted a Receiver, and when it was void of Air counterballanced it, upon turning the Stop-Cock and a Reingreſs of Air, it weighed 36 Grains more than before, which ſucceeded when tryed a ſecond time, and likewiſe a third. And then the Receiver being exhauſted was immerſed in Water, and the Stop-Cock turn'd to give way to an Ingreſs of Water, and when as much Water as was able to enter into the Receiver had ſucceeded in the Place of the exhauſted Air, we turned the Cock again to keep that Water in, and the Receiver being again weighed, the Water weighed 47 Ounces, 3 Drachms and 6 Grains, ſo that the Water was heavier than its bulk of Air, near 650 Grains, the Mercury in a Baroſcope at the ſame time being boyed up to 29 Inches ¾, ſo that the Weight and condenſed ſtate of the Atmoſphere being greater then than uſually, was the Reaſon why the Diſproportion was not as great as at other times; tho' we may reaſonably ſuſpect, that the Quantity of Air contained in the Pores of the Water, joyning with that in the Receiver, might hinder ſo much Water from getting in as was requiſite to fill the Space deſerted by the Exhauſted Air; beſides ſeveral Particles of Air might probably get in at the Stop-Cock, whilſt the Experiment was

trying, which joyning with the Air remaining in the Receiver might contribute to prevent a ſufficient Ingreſs of Water.

From all which Experiments it appears, that tho' the Weight of the Atmoſphere is ſo various, that it is impoſſible to know exactly the Proportion betwixt it and Water, yet it is evident that Water is to Air ſome Number betwixt 600 and 1100 to 1, being greater or leſs as the Atmoſphere is more or leſs condenſed. But theſe Tryals are only of uſe in *England*, for the Weight of Water as well as Air, is ſo different in moſt Countries, that it is requiſite to make frequent Experiments in each, to determine the Proportion of the Weight of Air in ſuch Places.

CHAP.

CHAP. II.

A ſecond Continuation of Phyſico-Mechanical Experiments.

PLATE III.

A Deſcription of the Engin with a double Tube to exhauſt the Air.

A. A. TWO Brazen Pumps.

B. B. Two hollow Plugs, the lower Part of whoſe Cylindrical Cavity is open. *See Plate 3. Fig. 1.*

C. C. Two ſmaller Orifices in the upper Baſis of the Plugs, furniſh'd with Valves, which open outward, ſo that the Air may get out, but cannot return into the Cavity of the Plugs again.

D. D. D. D. Iron Rods, fixed to the Gnomons, *F. F.* and deſigned to move the Plugs.

E. E. Two Iron Stirrups fixed to the Tops of the Rods *D. D. D. D.* deſigned for the Operator to ſtand in, to ſet the Engin a going.

G. G. G. A Rope which lies upon the Pully *H.* each End being tyed to the Stirrups *E. E.*

L. L. Two Valves placed at the Bottom of the Pumps, ſo that by opening inward, they may admit the Air out of the Tube *M. M.*

M. M. A Tube which rising from both Pumps, ends in the Plate *O. O.* Having first made a Curvature *P. P. Q. Q.* of a convenient length that the Tube *P. Q. Q.* may not hinder the Operator from standing in the Stirrups *E. E.*

O. O. A Plate perforated in the Middle to afford an Intercourse betwixt the Tube *P. Q. Q.* and the Receiver *R.*

See Plate 3. Fig. 2. To render this Engin fit for use, it must be supported in a Wooden Frame, (See *Fig.* the second;) and then a Quantity of Water being thrown into the Tube *P. Q. Q.* sufficient to fill the Pumps and something more, the Operator standing in the Stirrups, must weigh them up and down successively, one after another, which being done, as the Plug in each Pump is raised up, the Air contained in the Receiver *R.* and the Tube *Q. Q.* will by it's Spring and Expansion, lift up the Valves *L. L.* and make it's way into the Space deserted by the Plugs in the Pumps; but as soon as the Plugs begin to be prested down again, the Air contain'd in the Pumps will be hindred from passing into the Receiver by the Valves *K. L.* and consequently the whole Cavity of the Plugs being full of Water, the Air, as they are forc'd down, will lift up the Valve *C.* and so the Air contained in the Receiver will be successively drawn out as the Plugs move up and down alternately.

The Reasons why this double Engin is preferable to a single one, is because it evacuates the Receiver more speedily, and also with less trouble, for whereas in a single one the Pillar of Air which presses against the descending Sucker is to be resisted by force, as well to depress the Sucker

as

as to keep it from riſing up again, in this double one the Weight of the Atmoſphere depreſſes one Plug proportionably as it reſiſts the Riſing of the other, and the Motion of the Plugs up and down is rendered much more eaſy, when the Receiver is in ſome meaſure exhauſted, becauſe the Atmoſphere which lies upon the deſcending Sucker helps the Operator to weigh it down, the Spring of the included Air being ſo far weakned as not to reſiſt the Weight of the Atmoſpherical Pillar that lies upon it.

PLATE IV.

A deſcription of the Mercurial Gage made uſe of in the following Experiment.

The Gage *A. B. C. D. E.* is made up of three Glaſs Tubes cemented together, ſo that their Cavities make a continued Paſſage, being open to each other; The Tube *B. C. D.* is deſignedly crooked, that the lower Orifice of the Tube *E. D.* as well as the Orifice of Tube *A. B.* may be cemented to it; which being done, the crooked Tube, whoſe Diameter is larger than either of the other two, is to be filled with Mercury, and then the Orifice *E.* of the ſmaller Tube is to be hermetically Sealed up; but the Orifice *A.* of the Tube *A. B.* whoſe Diameter is larger than that of *E. D.* is to be left open. *See Plate 4. Fig. 1.*

This Gage being put in a Receiver when it is exhauſted, the Air contained in the Tube *E. D.* will expand ſo powerfully as to deſcend into the crooked one to *C.* forcing the Mercury to

rise into the Tube *B. A.* almost to the Top, before the included Air hath lost it's Spring.

To discover then the Quantity of Air included in a Receiver, we may make use of the Receiver *F. G. E.* which being placed on the Plate *L. M.* we must try the Torrecellian Experiment, by inverting the Tube *H.* fill'd with Mercury into the Glass *I.* and then the Top of the Receiver *F.* being clos'd with Cement, and the Tube *A. B.* and *E. D.* being mark'd with Papers, as the Mercury in the Receiver is suspended at 30, 29, or 28 Inches or less, accordingly as the Receiver is exhausted, the same Marks, *viz.* 30, 29, *&c.* being placed upon the Papers, pasted on the Tubes of the Mercurial Gage, at each distinct Surface of the expanded Air and the rising Mercury, for the future, when the Air and Mercury descend and ascend to those Marks, in the exhausted Receiver, it will denote, that the Receiver is so far exhausted, that the remaining Air is only able to bare up a Cylinder of Mercury in the Torrecellian Experiment, so many Inches as the Mark to which the lower Surface of the Air, and the upper Surface of the Mercury rest at, is more or less in Numbers.

But if the Air contain'd in the Receiver, be more than naturally compress'd, it will likewise compress the Air contain'd in the Tube *E. D.* by squeezing the Mercury somewhat into the lower part of the Tube. How much taller a Cylinder of Mercury Air so compress'd will bear up, than when it is but naturally condens'd, we may learn by the following Computation.

For

For ſuppoſing a determinate Quantity of Air to be contain'd in the Space *A.* when the Force that compreſſes it is *F.* if the Preſſure *F.* be increaſed by the Preſſure *G.* it will compreſs the Air contain'd in *A.* into half the ſpace it took up before; ſo that the remaining Space *B.* will be ½ a part of the Whole: And if to the Preſſure *F. G.* we add *H.* the Air which poſſeſſed the Space *A.* when it was only preſſed by *F.* will be ſqueez'd into a fourth Part of the Space *A. viz. C.* And conſequently the Air compreſs'd will poſſeſs a Space proportionable to the Whole, as the firſt Preſſure is to a total Preſſure. *See Fig. 2.*

The Remaining Space: the Total Space.

The Firſt Preſſure: the Total Preſſure.

So that three of thoſe Quantities being known, the Rule of Proportion will teach us the fourth. For if the *Atmoſphere* as uſually condens'd in *England*, poſſeſſes the Tube *E. D.* and the *Atmoſphere* is then able to raiſe a Mercurial Tube of 30 Inches; When that Air is compreſs'd into the Space *N. E.* to know the Quantity of it's Preſſure, I exactly meaſure the Space *N. E.* which if 6 Inches, I conſtitute that the firſt Term or Quantity of Preſſure; ſo that the ſecond Term will be the whole Space *D. E.* ſuppoſe 12 Inches; the third Term will be the Height of 30 Inches of Mercury, which was the firſt Preſſure; and ſo the fourth Term or total Preſſure will be found to be 60 Inches of Mercury; From whence I conclude, the Air ſo condens'd in the Receiver, to be able to bear up a Mercurial Cylinder 60 Inches tall.

And

And by the same Principle before laid down, it will be no difficult matter to judge, what the Proportion betwixt the size of the Tube *A. B.* and *E. D.* ought to be; for that depending on the Length of the Legs, the higer they are, the more able they are to restrain the Air, when it is but a little dilated in the sealed Part. For supposing the Length of *A. B.* to be 10 Inches, which Height of the Mercury is $\frac{1}{3}$ of the usual Pressure; the Tube *A. B.* will be large enough if it be as big again as *E. D.* for when the Mercury hath ascended to *A.* the expanded Air in the other Leg possessing the Space which it forced the Mercury out of, will take up three times as much more as it did before; and consequently, $\frac{1}{3}$ of it's first Pressure will be able to curb it's Spring: But if the Legs were not altogether so long, then the Mercury being but partly expell'd out of the crooked Tube, the Diameter of the Tube *A. B.* ought to be proportionably larger in respect of *E. D.* That the ascending Mercury leaving it more space to expand in, it's Spring may be so far spent, that the Mercury by it's Weight may seasonably resist it's further Expansion: And it would always answer, if the Height of the Gage be in the same proportion to 30 Inches, as the Space first possessed by the Air is to the Whole, which that Air would possess in *Vacuo*, according to the Principle above delivered.

The Tube is more useful when longer, than shorter, because the expanding Air being more able to drive the Mercury into the Tube *A. B.* more Degrees of it's Rarefaction will be discovered, tho' less sensibly. But

The

The *D. C.* ought to hold Mercury enough to fill the Tube *A. B.* before the Air in the Tube *E. D.* can make it's way out; But how much larger, or of what Figure it is, is not so material.

A Description of the Engin made to compress Air.

A. A. A Glass Vessel, whose Orifice is exactly cover'd by a Brazen Plate *B. B.* *See Plate 4. Fig. 3.*

C. C. A Brass Tube penetrating that Plate in the middle, to which it is fixed.

E. A small Valve, which opens inward, and covers the Orifice of the Tube *C.*

E. A Spring which presses it down.

G. G. G. A Gnomon fix'd to the Plate *B. B.* to hold down the Spring *F.*

I. I. A square Lath which the Plate *B. B.* lies upon, which is bored through in the Middle for the Tube *C.* to pass through.

L. L. L. L. L. L. Two Iron Wyres which being fix'd in the Lath, and encompassing the Iron Plate *K. K.* keep it from rising too high. In the Middle of the Plate *K. K.* is a Screw *M. M.* which joyns the Receiver and the Plate *B, B.* close together. And that the Receiver may neither be damaged by the Screw, nor the Glass by the Iron Plate, a piece of Wood and Leather is put betwixt the former, and as well to prevent damage as to render the Receiver closer, a piece of Leather is to be put upon the Plate.

N. N. A Pump fixed to the Tube *C.* below the Plate *B. B.*

O. O.

O. O. The Sucker.

P. A small Orifice at which the Air enters in, when the Sucker is brought to the Bottom of the Pump.

When we have a mind to compress any thing in the Air, we conveigh it into the Receiver thus prepared; and drawing down the Sucker, that the Air may enter in at the Orifice *P.* and fill the upper part of the Cylinder, we raise the Valve, by which means the Air lifts up the Sucker, and makes it's way into the Receiver, till the Sucker being drawn down again, the Valve closes up the Orifice of the Pipe *C.* and so successively keeps the Air in the Receiver as it is forced in, the State of the prest Air being made evident by the Mercurial Gage.

If the Pump be fixed to the Pipe *C.* by a Screw, when one Receiver is full, it may be removed to another.

The Mercurial Gage described in the first Figure will not so evidently shew the different Degrees of the Air's Condensation as the Gage *T.* for the whole Tube being full of Air, except one Inch, the Condensation of so great a Quantity will be more evident.

But here it will be requisite to note in very accurate Experiments, that tho' the Figure of this Gage makes it fit for short Receivers, yet if the Mercury be, when the Air is compressed, squeez'd down or upwards, it's Gravity causes some difference in the Degrees of Pressure, which is not to be slighted.

PLATE

PLATE IV.

How Mixtures may be made in compreſſed Air. *See Fig. 3.*

A. A. The Receiver in which they are to be made.

Q. Q. R. R. Two Tubes, the one End of each of which is ſealed, and the other open.

R. R. S. A Brazen Veſſel laid upon the Orifice of each.

The Subſtances to be mixed muſt be each put into a diſtinct Tube *Q. Q. R. R.* The Veſſel of *R. Q. S.* being inverted, and laid upon their Orifices, and being thus conveighed into the Receiver, when the Gage *T. T.* ſhews that by the help of the Pump, the Air is ſufficiently compreſs'd, by inverting the Engin, the Subſtances contained in the Tubes, will be mixed together in the Veſſel which was inverted on the Tops of the Tubes, when placed firſt in the Receiver.

PLATE IV.

A Deſcription of a Wind-Gun.

A. A. A hollow Copper Globe. *See Fig. 4.*

B. B. A Tube fixed to it.

F. A Valve opening internally, and ſhutting the Tube *B. B.*

G. A Spring to depreſs that Valve.

H. A Gnomon ſo placed as to keep the Spring faſt.

C. C. An Iron Tube fixed to the Tube *B. B.* and the Globe *A. A.*

D. D.

O. O. The Sucker.

P. A small Orifice at which the Air enters in, when the Sucker is brought to the Bottom of the Pump.

When we have a mind to compress any thing in the Air, we conveigh it into the Receiver thus prepared; and drawing down the Sucker, that the Air may enter in at the Orifice *P.* and fill the upper part of the Cylinder, we raise the Value, by which means the Air lifts up the Sucker, and makes it's way into the Receiver, till the Sucker being drawn down again, the Valve closes up the Orifice of the Pipe *C.* and so successively keeps the Air in the Receiver as it is forced in, the State of the prest Air being made evident by the Mercurial Gage.

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D. D.

D. D. A Plug adapted to the Cylindrical Cavity of that Tube.

E. E. E. Another adapted to the Tube *B. B.* with a Wyre which almoſt reaches to the Valve *F.*

R. The Protuberance of the Tube *C. C.* whoſe upper Part is deſignedly hollow, to receive the End of the Iron *L. L.*

L. L. A crooked Iron, whoſe End *R.* being moveable, helps to lift up the Plug *E. E. E.*

O. P. O. A crooked piece of Iron, fixed in *M.* that the Shoulder might be ſet againſt it when any Mark is aimed at, and that the Thumb being ſet againſt the bending *P.* in preſſing up the Plug *E. E. E.* the Fingers might more vigorouſly draw up the Leaver *L.*

T. T. A Rectangle of Iron, compaſſing the Leaver *L. L.* and the Iron *O. P. O.* to keep it in ſuch a Poſture, that the Plug may not fly out, whilſt the Air is compreſſed into the Globe *A. A.*

I. I. An Elliptick Hole which is ſhut with a Valve that opens inward; the Deſign of it is, that what is amiſs in the Globe, may be ſeen and mended.

S. S. A Plate of Metal perforated with a Screw *V.* which ſuſtains the Valve, and keeps the Hole *U.* ſhut.

Q. A Hole for the Air, which is to be preſſed into the Globe to enter in at, when the Sucker *D.* is pulled down to the lower End of the Tube *C. C.*

The Method to preſs Air into this Globe is this; I ſet my Foot upon the crooked End of the Sucker *D.* and then pulling up the Globe, as ſoon

ſoon as the Tube *C. C.* is full of Air, I depreſs the Globe, by which means the Air in the Tube is forced into it through the Valve *F.* and this Method being taken as long as the Air's Spring would permit us to compreſs it any further, the Air may be diſcharged, if, when the Plug *D.* is drawn out, and a Bullet is put into the Tube inſtead of it, the Plug *E. E. E.* be raiſed ſo that the End of the Iron Wire may open the Valve *B.* for the Air violently ruſhing out, will drive the Bullet away with great Violence.

The Globe will be ſooner filled with Air, if half an Ounce of Water be put into the Tube *C. C.* before the Sucker *D.* for the Top of the Tube being filled with Water, the Air will be forced clearly out of the Tube into the Globe.

And this Wind-Gun hath theſe Advantages above any other yet mentioned; Firſt, that it is not ſo ſubject to be ſpoiled, as thoſe that have two Valves; Secondly, it is eaſily mended, what is amiſs being taken out at the Elliptick Hole. Thirdly, it is much more ſtanch, the Crannies being ſtopped with Silver Soder, which damages not the Leather on the Valve, becauſe it is put in after the Soder is cooled, at the Elliptick Hole. Fourthly, ſeveral Bodies may be conveighed into it at the Elliptick Hole, whereby we may be enabled to try ſeveral Experiments.

PLATE V.

How Factitious Air may pass out of one Receiver into another.

A. A. A Metalline Plate perforated in the Middle.

B. B. To which a Stop-Cock is fixed, the lower Orifice being made into a Male Screw.

D. C. Which is received by the Female Screw *D.* of the Copper Funnel *D. C.*

See Fig. 2. *E. E.* A hollow Tube, both of whose Ends are formed into a Female Screw, to receive the Male Screw of the Stop-Cock *B. B.*

See Fig. 1. *F. F.* The Receiver laid on the Plate *A. A.* and exactly fitted to it.

The Matter of which factitious Air is to be made, is to be put into the Receiver *F. F.* and the Orifice of the Tunnel *C.* being placed on the Receiver, and the Stop-Cock *B.* being open'd, the Air is to be drawn out of the Receiver, which being done, the Stop-Cock is to be shut again, and the Male Screw being taken out of the Female Screw in the Brass Tunnel, the Receiver is to be immers'd in Water to keep External Air out; As for the Degrees of Compression of the factitious Air, they may be discover'd by the Mercurial Gage before mention'd.

To transmit this Air into another Receiver *F. F.* we make use of the small Tube *E. E. Fig.* the Second, into each End of which the Stop-Cocks of two Receivers being screw'd, and the Cran-

Crannies ſtopp'd with Cement, by turning the Stop-Cocks, the Air may be let out of one into the other.

To diſcover the Rarefaction of the Air contain'd in which Receivers, becauſe they muſt be inverted, we contriv'd the following Gage.

A. A. A Viol filled with Mercury up to the Superficies *D. D.* *See Fig. 4.*

B. B. A Tube cemented in the Neck of it.

C. C. Another which paſſing through the Tube *B. B.* leaves room for a due intercourſe betwixt the External and Internal Air, the upper End of which muſt be ſeal'd, and the other End open.

If this Gage be put into a Receiver when it is inverted, both the Tubes will have the Air contain'd in them exhauſted, and will be ready to receive factitious Air, as ſoon as the Stop-Cocks are turn'd to give an Intercourſe betwixt them; and then the Gage being inverted, and the Mercury which lay below the Orifice of the Tube *B. B.* falling about the Pipe *C. C.* by riſing up into it, will ſhew the Degrees of the Compreſſion of that factitious Air.

PLATE VI.

An Inſtrument by which Air may be filtrated through Water.

A. A. A Glaſs Receiver whoſe Orifice is adapted to the Plate *B. B.* which is perforated in the Middle by the Tubes *C. C.* *D. D.* which are cemented to it. *See Fig. 1.*

E. E. E. E. A Stop-Cock into which the lower Ends of the Tubes *C. C. D. D.* are inserted.

F. F. The Key of the Stop-Cock in which is made the Chink *G. G.* without any Perforation.

H. H. The Receiver to which the Stop-Cock is fix'd, preventing an Ingress of outward Air, and having a due Intercourse with the Pump *I. I.*

L. L. A Glass Vessel.

M. The Stopple in the Top of the Receiver fasten'd with a Screw.

See Fig. 2. A Stop-Cock cut transverse, so that the Insertions of the Tubes *C. C. D. D.* into the Stop-Cocks may be perceived.

The Use of this Instrument is as follows, To try how much Air may acquire new Qualities in respect of a Body included with it, we conveigh that Body into the Vessel, and then pouring a sufficient Quantity of Water at the Orifice *M.* until the Receiver *A. A.* be half full, and the Vessel *L. L.* swim up to the Top of it, the Orifice *M.* is stopped up, which being done, and the Key so placed, that the Tube *C. C.* may communicate with the Chink *G. G.* upon drawing down the Sucker, the Air in the Receiver *A. A.* will pass through the Pipes *C. C.* and the Chink *G. G.* into the Receiver *H. H.* and from thence into the Pump: Upon which, the Chink in the Stop-Cock being turn'd so as to communicate with the Insertions of the Tube *D. D.* and then the Sucker being rais'd to the Top of the Cylinder, the Air will be impell'd into the Tube *D. D.* and emerging through the Water, will rise into the Top of the Receiver *A. A.* and by this Method we could strain it through Water

ter as often as we had a mind to be inform'd, what new Qualities it acquir'd in reference to the Bodies about it.

FIGURE III.

How the ſame Numerical Air may be ſometimes condenſed, and ſometimes rarified.

The Receiver *A. A.* being fix'd upon the Plate *B. B.* and the Stop-Cock *C. C.* being fix'd to the Perforation of the Plate *B. B.*

The Pump *D. D.* is joyn'd by a Screw to the Stop-Cock *C.*

E. A Veſſel which fluctuates in the Receiver, in which an Animal being put, and the Pump fill'd with Water, and joyn'd to the Stop-Cock by a Screw, the Water contain'd in the Pump will, by lifting up the Sucker, be forc'd into the Receiver, and by that means condenſe the Air, without an addition of new, and by drawing the Sucker down again, the ſame parcel of Air will be again expanded; ſo that Obſervations may be made, how much the thickneſs or thinneſs of Air contributes to the preſervation of the life or health of Animals.

PLATE VII.

An Inſtrument to diſtil in Vacuo,

A. A. A Brazen Veſſel, the lower part of which is ſhut, and the upper open. *See Fig.*

B. B. A piece of Tin exquiſitely adapted to the Tube, ſo as to prevent the External Air

from entring in, being adapted to the Edges of it *A. A. D. D.*

C. C. A Tube fix'd in the middle of the Tin Plate *B. B.*

D. D. A Brazen Vessel, whose Orifice is contiguous to *B. B.*

E. E. A Stop-Cock fix'd to the Perforation in the Plate *B. B.*

F. F. A Tube reaching from the Stop-Cock to the Pneumatick Engin.

G. G. A metalline Vessel enclosing the Junctures of the Vessels with the *Diaphragma*, and also the Stop-Cock, that by keeping them immers'd in Water, they may be free from External Air; this is cemented to the Vessel *A.* with Soder.

The manner of using this Engin is the following, *viz.* The Tin Plate being remov'd, and the Ingredients to be boil'd, being put into the Vessel *A. A.* then re-applying the Tin Plate *A. A.* and the Vessel *D. D.* and the Tube *F. F.* being apply'd to the Pneumatick Engin, and the Air pump'd out, the Vessel *G. G.* having been first fill'd with Water, we shut the Stop-Cock, and remove the Tube *F. F.* and then the exhausted Vessel being placed on the Fire, Vapours will ascend through the Tube *C. C.* which will be condens'd in the upper Vessel; and what Quantity of Air is there generated, will appear by the Mercurial Gage *H.* in the Top of the Vessel.

But here it is to be noted, that round pieces of perforated Paper being laid upon the Orifices of the Vessels *A. A. D. D.* they will be more exactly joyn'd with the Tin Plate. The Junctures of the

the Tube *F. F.* both with the Pneumatick Engin and Stop-Cock are to be guarded with Cement, and the Stop-Cock muſt be ſo contriv'd, as to ſtand ſo far without the Veſſel *G.* that it may be conveniently turn'd: When any thing is to be conveigh'd into the Veſſel, the Tin Plate *E. E.* and the Stop-Cock may be laid aſide: Which may be done without any great Difficulty; for the Key being made up of two parts, the one of which *M.* is turn'd in the Stop-Cock, by a Chink, into which the End of the other part *O. O.* which fills the Pipe *N. N.* fix'd to the Veſſel *G. G.* is receiv'd, ſo that one End being prominent outwardly, whilſt it is turn'd, it may communicate Motion to the other Part *M.* But whilſt the Tin Plate *B. B.* is is to be taken out of the Veſſel *G. G.* it muſt be drawn outward.

Another Inſtrument for the ſame Uſe with the former. Fig. 2.

B. B. A ſmall Tube, both Ends of which are poliſh'd, that it may be exactly adapted to the Orifices of the Veſſels *A.* and *D.*

A. A. D. D. Two Veſſels made of Glaſs, ſo joyn'd by the Tube *B. B.* that Vapours may paſs from one to the other.

E. E. F. F. G. G. I. Are of the ſame Uſe with the firſt *Figure*, and the Inſtrument is to be evacuated by the ſame Method; only the Glaſs Veſſel muſt be placed in *Balneo Mariæ*, or on Sand, and the Vapours ſo rais'd will condenſe in the Veſſel *D. D.*

CHAP. III.

ARTICLE. I.

Several Ways to help the Production of the Air.

EXPERIMENT I.

Bread

TO try whether a piece of Bread, which was moiſt, and a little kneaded, would yield Air; I included it in *Vacuo* with a Mercurial Gage, [illegible] but it yielded none: [illegible] Papers, paſted on the Tubes of the Mercurial Gage, at each diſtinct Surface of the expanded Air and the riſing Mercury, for the future, when the Air and Mercury deſcend and aſcend to thoſe Marks, in the exhauſted Receiver, it will denote, that the Receiver is ſo far exhauſted, that the remaining Air is only able to bare up a Cylinder of Mercury in the Torrecellian Experiment, ſo many Inches as the Mark to which the lower Surface of the Air, and the upper Surface of the Mercury reſt at, is more or leſs in Numbers.

But if the Air contain'd in the Receiver, be more than naturally compreſs'd, it will likewiſe compreſs the Air contain'd in the Tube *F. D.* by ſqueezing the Mercury ſomewhat into the lower part of the Tube. How much taller a Cylinder of Mercury Air ſo compreſs'd will bear up, than when it is but naturally condens'd, we may learn by the following Computation.

For

EXPERIMENT III.

Septemb. 22.

I Enclos'd in a Receiver, Eight Ounces of dry'd Grapes, bruis'd in 7 Ounces of Water, the Receiver being large enough to contain 22 Ounces. *From Grapes.*

Septemb. 23.

Tho' the Receiver was cover'd with Water all Night, the Mercury was rais'd two Inches.

Septemb. 30.

In seven Days it was rais'd thirteen Inches.

Octob. 9.

In five Days more it was [illegible] Inches high.

The Remaining Space: the Total Space.

The First Preſſure: the Total Preſſure.

So that three of thoſe Quantities being known, the Rule of Proportion will teach us the fourth. For if the *Atmoſphere* as uſually condens'd in *England*, poſſeſſes the Tube *E. D.* and the *Atmoſphere* is then able to raiſe a Mercurial Tube of 30 Inches; When that Air is compreſs'd into the Space *N. E.* to know the Quantity of it's Preſſure, I exactly meaſure the Space *N. E.* which if 6 Inches, I conſtitute that the firſt Term or Quantity of Preſſure; ſo that the ſecond Term will be the whole Space *D. E.* ſuppoſe 12 Inches; the third Term will be the Height of 30 Inches of Mercury, which was the firſt Preſſure; and ſo the fourth Term or total Preſſure will be found to be 60 Inches of Mercury; From whence I conclude, the Air ſo condens'd in the Receiver, to be able to bear up a Mercurial Cylinder 60 Inches tall.

And

And by the ſame Principle before laid down, it will be no difficult matter to judge, what the Proportion betwixt the ſize of the Tube *A. B.* and *E. D.* ought to be; for that depending on the Length of the Legs, the higer they are, the more able they are to reſtrain the Air, when it is but a little dilated in the ſealed Part. For ſuppoſing the Length of *A. B.* to be 10 Inches, which Height of the Mercury is ⅓ of the uſual Preſſure; the Tube *A. B.* will be large enough if it be as big again as *E. D.* for when the Mercury hath aſcended to *A.* the expanded Air in the other Leg poſſeſſing the Space which it forced the Mercury out of, will take up three times as much more as it did before; and conſequently, ⅓ of it's firſt Preſſure will be able to curb it's Spring: But if the Legs were not altogether ſo long, then the Mercury being but partly expell'd out of the crooked Tube, the Diameter of the Tube *A. B.* ought to be proportionably larger in reſpect of *E. D.* That the aſcending Mercury leaving it more ſpace to expand in, it's Spring may be ſo far ſpent, that the Mercury by it's Weight may ſeaſonably reſiſt it's further Expanſion: And it would always anſwer, if the Height of the Gage be in the ſame proportion to 30 Inches, as the Space firſt poſſeſſed by the Air is to the Whole, which that Air would poſſeſs in *Vacuo*, according to the Principle above delivered.

The Tube is more uſeful when longer, than ſhorter, becauſe the expanding Air being more able to drive the Mercury into the Tube *A. B.* more Degrees of it's Rarefaction will be diſcovered, tho' leſs ſenſibly. But

The

The *D. C.* ought to hold Mercury enough to fill the Tube *A. B.* before the Air in the Tube *E. D.* can make it's way out; But how much larger, or of what Figure it is, is not ſo material.

A Deſcription of the Engin made to compreſs Air.

A. A. A Glaſs Veſſel, whoſe Orifice is exactly cover'd by a Brazen Plate *B. B.* *See Plate 4. Fig. 3.*

C. C. A Braſs Tube penetrating that Plate in the middle, to which it is fixed.

E. A ſmall Valve, which opens inward, and covers the Orifice of the Tube *C.*

E. A Spring which preſſes it down.

G. G. G. A Gnomon fix'd to the Plate *B. B.* to hold down the Spring *F.*

I. I. A ſquare Lath which the Plate *B. B.* lies upon, which is bored through in the Middle for the Tube *C.* to paſs through.

L. L. L. L. L. L. Two Iron Wyres which being fix'd in the Lath, and encompaſſing the Iron Plate *K. K.* keep it from riſing too high. In the Middle of the Plate *K. K.* is a Screw *M. M.* which joyns the Receiver and the Plate *B. B.* cloſe together. And that the Receiver may neither be damaged by the Screw, nor the Glaſs by the Iron Plate, a piece of Wood and Leather is put betwixt the former, and as well to prevent damage as to render the Receiver cloſer, a piece of Leather is to be put upon the Plate.

N. N. A Pump fixed to the Tube *C.* below the Plate *B. B.*

O. O.

O. O. The Sucker.

P. A ſmall Orifice at which the Air enters in, when the Sucker is brought to the Bottom of the Pump.

When we have a mind to compreſs any thing in the Air, we conveigh it into the Receiver thus prepared; and drawing down the Sucker, that the Air may enter in at the Orifice *P.* and fill the upper part of the Cylinder, we raiſe the Value, by which means the Air lifts up the Sucker, and makes it's way into the Receiver, till the Sucker being drawn down again, the Valve cloſes up the Orifice of the Pipe *C.* and ſo ſucceſſively keeps the Air in the Receiver as it is forced in, the State of the preſſed Air being made evident by the Mercurial Gage.

If the Pump be fixed to the Pipe *C.* by a Screw, when one Receiver is full, it may be removed to another.

The Mercurial Gage deſcribed in the firſt Figure will not ſo evidently ſhew the different Degrees of the Air's Condenſation as the Gage *T.* for the whole Tube being full of Air, except one Inch, the Condenſation of ſo great a Quantity will be more evident.

But here it will be requiſite to note in very accurate Experiments, that tho' the Figure of this Gage makes it fit for ſhort Receivers, yet if the Mercury be, when the Air is compreſſed, ſqueez'd down or upwards, it's Gravity cauſes ſome difference in the Degrees of Preſſure, which is not to be ſlighted.

PLATE

PLATE IV.

How Mixtures may be made in compreſſed Air. *See Fig. 3.*

A. A. The Receiver in which they are to be made.

Q. Q. R. R. Two Tubes, the one End of each of which is ſealed, and the other open.

R. R. S. A Brazen Veſſel laid upon the Orifice of each.

The Subſtances to be mixed muſt be each put into a diſtinct Tube *Q. Q. R. R.* The Veſſel of *R. Q. S.* being inverted, and laid upon their Orifices, and being thus conveighed into the Receiver, when the Gage *T. T.* ſhews that by the help of the Pump, the Air is ſufficiently compreſs'd, by inverting the Engin, the Subſtances contained in the Tubes, will be mixed together in the Veſſel which was inverted on the Tops of the Tubes, when placed firſt in the Receiver.

PLATE IV.

A Deſcription of a Wind-Gun.

A. A. A hollow Copper Globe. *See Fig. 4.*

B. B. A Tube fixed to it.

F. A Valve opening internally, and ſhutting the Tube *B. B.*

G. A Spring to depreſs that Valve.

H. A Gnomon ſo placed as to keep the Spring faſt.

C. C. An Iron Tube fixed to the Tube *B. B.* and the Globe *A. A.*

D. D.

O. O. The Sucker.

P. A ſmall Orifice at which the Air ent

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H. A Gnomon ſo placed as to keep the Spring faſt.
C. C. An Iron Tube fixed to the Tube *B. B.* and the Globe *A. A.*

D. D.

D. D. A Plug adapted to the Cylindrical Cavity of that Tube.

E. E. E. Another adapted to the Tube *B. B.* with a Wyre which almoſt reaches to the Valve *F.*

R. The Protuberance of the Tube *C. C.* whoſe upper Part is deſignedly hollow, to receive the End of the Iron *L. L.*

L. L. A crooked Iron, whoſe End *R.* being moveable, helps to lift up the Plug *E. E. E.*

O. P. O. A crooked piece of Iron, fixed in *M.* that the Shoulder might be ſet againſt it when any Mark is aimed at, and that the Thumb being ſet againſt the bending *P.* in preſſing up the Plug *E. E. E.* the Fingers might more vigorouſly draw up the Leaver *L.*

T. T. A Rectangle of Iron, compaſſing the Leaver *L. L.* and the Iron *O. P. O.* to keep it in ſuch a Poſture, that the Plug may not fly out, whilſt the Air is compreſſed into the Globe *A. A.*

I. I. An Elliptick Hole which is ſhut with a Valve that opens inward; the Deſign of it is, that what is amiſs in the Globe, may be ſeen and mended.

S. S. A Plate of Metal perforated with a Screw *V.* which ſuſtains the Valve, and keeps the Hole *U.* ſhut.

Q. A Hole for the Air, which is to be preſſed into the Globe to enter in at, when the Sucker *D.* is pulled down to the lower End of the Tube *C. C.*

The Method to preſs Air into this Globe is this; I ſet my Foot upon the crooked End of the Sucker *D.* and then pulling up the Globe, as ſoon

ſoon as the Tube *C. C.* is full of Air, I depreſs the Globe, by which means the Air in the Tube is forced into it through the Valve *F.* and this Method being taken as long as the Air's Spring would permit us to compreſs it any further, the Air may be diſcharged, if, when the Plug *D.* is drawn out, and a Bullet is put into the Tube inſtead of it, the Plug *E. E. E.* be raiſed ſo that the End of the Iron Wire may open the Valve *B.* for the Air violently ruſhing out, will drive the Bullet away with great Violence.

The Globe will be ſooner filled with Air, if half an Ounce of Water be put into the Tube *C. C.* before the Sucker *D.* for the Top of the Tube being filled with Water, the Air will be forced clearly out of the Tube into the Globe.

And this Wind-Gun hath theſe Advantages above any other yet mentioned; Firſt, that it is not ſo ſubject to be ſpoiled, as thoſe that have two Valves; Secondly, it is eaſily mended, what is amiſs being taken out at the Elliptick Hole. Thirdly, it is much more ſtanch, the Crannies being ſtopped with Silver Soder, which damages not the Leather on the Valve, becauſe it is put in after the Soder is cooled, at the Elliptick Hole. Fourthly, ſeveral Bodies may be conveighed into it at the Elliptick Hole, whereby we may be enabled to try ſeveral Experiments.

PLATE

PLATE V.

How Factitious Air may paſs out of one Receiver into another.

A. A. A Metalline Plate perforated in the Middle.

B. B. To which a Stop-Cock is fixed, the lower Orifice being made into a Male Screw.

D. C. Which is received by the Female Screw *D.* of the Copper Funnel *D. C.*

See Fig. 2. *E. E.* A hollow Tube, both of whoſe Ends are formed into a Female Screw, to receive the Male Screw of the Stop-Cock *B. B.*

See Fig. 1. *F. F.* The Receiver laid on the Plate *A. A.* and exactly fitted to it.

The Matter of which factitious Air is to be made, is to be put into the Receiver *F. F.* and the Orifice of the Tunnel *C.* being placed on the Receiver, and the Stop-Cock *B.* being open'd, the Air is to be drawn out of the Receiver, which being done, the Stop-Cock is to be ſhut again, and the Male Screw being taken out of the Female Screw in the Braſs Tunnel, the Receiver is to be immers'd in Water to keep External Air out; As for the Degrees of Compreſſion of the factitious Air, they may be diſcover'd by the Mercurial Gage before mention'd.

To tranſmit this Air into another Receiver *F. F.* we make uſe of the ſmall Tube *E. E. Fig.* the Second, into each End of which the Stop-Cocks of two Receivers being ſcrew'd, and the Cran-

Crannies ſtopp'd with Cement, by turning the Stop-Cocks, the Air may be let out of one into the other.

To diſcover the Rarefaction of the Air contain'd in which Receivers, becauſe they muſt be inverted, we contriv'd the following Gage.

A. A. A Viol filled with Mercury up to the Superficies *D. D.* *See Fig. 4.*

B. B. A Tube cemented in the Neck of it.

C. C. Another which paſſing through the Tube *B. B.* leaves room for a due intercourſe betwixt the External and Internal Air, the upper End of which muſt be ſeal'd, and the other End open.

If this Gage be put into a Receiver when it is inverted, both the Tubes will have the Air contain'd in them exhauſted, and will be ready to receive factitious Air, as ſoon as the Stop-Cocks are turn'd to give an Intercourſe betwixt them; and then the Gage being inverted, and the Mercury which lay below the Orifice of the Tube *B. B.* falling about the Pipe *C. C.* by riſing up into it, will ſhew the Degrees of the Compreſſion of that factitious Air.

PLATE VI.

An Inſtrument by which Air may be filtrated through Water.

A. A. A Glaſs Receiver whoſe Orifice is adapted to the Plate *B. B.* which is perforated in the Middle by the Tubes *C. C. D. D.* which are cemented to it. *See Fig. 1.*

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PLATE VI.

An Inſtrument by which Air may be filtrated through Water.

A. A. A Glaſs Receiver whoſe Orifice is adapted to the Plate *B. B.* which is perforated in the Middle by the Tubes *C. C. D. D.* which are cemented to it. *See Fig. 1.*

E. E. E. E. A Stop-Cock into which the lower Ends of the Tubes *C. C. D. D.* are inſerted.

F. F. The Key of the Stop-Cock in which is made the Chink *G. G.* without any Perforation.

H. H. The Receiver to which the Stop-Cock is fix'd, preventing an Ingreſs of outward Air, and having a due Intercourſe with the Pump *I. I.*

L. L. A Glaſs Veſſel.

M. The Stopple in the Top of the Receiver faſten'd with a Screw.

See Fig. 2. A Stop-Cock cut tranſverſe, ſo that the Inſertions of the Tubes *C. C. D. D.* into the Stop-Cocks may be perceived.

The Uſe of this Inſtrument is as follows, To try how much Air may acquire new Qualities in reſpect of a Body included with it, we conveigh that Body into the Veſſel, and then pouring a ſufficient Quantity of Water at the Orifice *M.* until the Receiver *A. A.* be half full, and the Veſſel *L. L.* ſwim up to the Top of it, the Orifice *M.* is ſtopped up, which being done, and the Key ſo placed, that the Tube *C. C.* may communicate with the Chink *G. G.* upon drawing down the Sucker, the Air in the Receiver *A. A.* will paſs through the Pipes *C. C.* and the Chink *G. G.* into the Receiver *H. H.* and from thence into the Pump: Upon which, the Chink in the Stop-Cock being turn'd ſo as to communicate with the Inſertions of the Tube *D. D.* and then the Sucker being rais'd to the Top of the Cylinder, the Air will be impell'd into the Tube *D. D.* and emerging through the Water, will riſe into the Top of the Receiver *A. A.* and by this Method we could ſtrain it through Water

ter as often as we had a mind to be inform'd, what new Qualities it acquir'd in reference to the Bodies about it.

FIGURE III.

How the ſame Numerical Air may be ſometimes condenſed, and ſometimes rarified.

The Receiver *A. A.* being fix'd upon the Plate *B. B.* and the Stop-Cock *C. C.* being fix'd to the Perforation of the Plate *B. B.*

The Pump *D. D.* is joyn'd by a Screw to the Stop-Cock *C.*

E. A Veſſel which fluctuates in the Receiver, in which an Animal being put, and the Pump fill'd with Water, and joyn'd to the Stop-Cock by a Screw, the Water contain'd in the Pump will, by lifting up the Sucker, be forc'd into the Receiver, and by that means condenſe the Air, without an addition of new, and by drawing the Sucker down again, the ſame parcel of Air will be again expanded; ſo that Obſervations may be made, how much the thickneſs or thinneſs of Air contributes to the preſervation of the life or health of Animals.

PLATE VII.

An Inſtrument to diſtil in Vacuo,

A. A. A Brazen Veſſel, the lower part of which is ſhut, and the upper open. *See Fig.*

B. B. A piece of Tin exquiſitely adapted to the Tube, ſo as to prevent the External Air

from entring in, being adapted to the Edges of it *A. A. D. D.*

C. C. A Tube fix'd in the middle of the Tin Plate *B. B.*

D. D. A Brazen Veſſel, whoſe Orifice is contiguous to *B. B.*

E. E. A Stop-Cock fix'd to the Perforation in the Plate *B. B.*

F. F. A Tube reaching from the Stop-Cock to the Pneumatick Engin.

G. G. A metalline Veſſel encloſing the Junctures of the Veſſels with the *Diaphragma*, and alſo the Stop-Cock, that by keeping them immers'd in Water, they may be free from External Air; this is cemented to the Veſſel *A.* with Soder.

The manner of uſing this Engin is the following, *viz.* The Tin Plate being remov'd, and the Ingredients to be boil'd, being put into the Veſſel *A. A.* then re-applying the Tin Plate *A. A.* and the Veſſel *D. D.* and the Tube *F. F.* being apply'd to the Pneumatick Engin, and the Air pump'd out, the Veſſel *G. G.* having been firſt fill'd with Water, we ſhut the Stop-Cock, and remove the Tube *F. F.* and then the exhauſted Veſſel being placed on the Fire, Vapours will aſcend through the Tube *C. C.* which will be condens'd in the upper Veſſel; and what Quantity of Air is there generated, will appear by the Mercurial Gage *H.* in the Top of the Veſſel.

But here it is to be noted, that round pieces of perforated Paper being laid upon the Orifices of the Veſſels *A. A. D. D.* they will be more exactly joyn'd with the Tin Plate. The Junctures of the

the Tube *F. F.* both with the Pneumatick Engin and Stop-Cock are to be guarded with Cement, and the Stop-Cock muſt be ſo contriv'd, as to ſtand ſo far without the Veſſel *G.* that it may be conveniently turn'd: When any thing is to be conveigh'd into the Veſſel, the Tin Plate *E. E.* and the Stop-Cock may be laid aſide: Which may be done without any great Difficulty; for the Key being made up of two parts, the one of which *M.* is turn'd in the Stop-Cock, by a Chink, into which the End of the other part *O. O.* which fills the Pipe *N. N.* fix'd to the Veſſel *G. G.* is receiv'd, ſo that one End being prominent outwardly, whilſt it is turn'd, it may communicate Motion to the other Part *M.* But whilſt the Tin Plate *B. B.* is is to be taken out of the Veſſel *G. G.* it muſt be drawn outward.

Another Inſtrument for the ſame Uſe with the former. Fig. 2.

B. B. A ſmall Tube, both Ends of which are poliſh'd, that it may be exactly adapted to the Orifices of the Veſſels *A.* and *D.*

A. A. D. D. Two Veſſels made of Glaſs, ſo joyn'd by the Tube *B. B.* that Vapours may paſs from one to the other.

E. E. F. F. G. G. I. Are of the ſame Uſe with the firſt *Figure*, and the Inſtrument is to be evacuated by the ſame Method; only the Glaſs Veſſel muſt be placed in *Balneo Mariæ*, or on Sand, and the Vapours ſo rais'd will condenſe in the Veſſel *D. D.*

CHAP. III.

ARTICLE. I.

Several Ways to help the Production of the Air.

EXPERIMENT I.

Air produced from Bread.

TO try whether a piece of Bread, which was moiſt, and a little kneaded, would yield Air; I included it in *Vacuo* with a Mercurial Gage, *July* 12*th* 76. but it yielded none: On the 12*th*. ſome broke in the Receiver, and raiſed Mercury 3 Inches high; and at Night it was rais'd an Inch higher, tho' no external Air got in. *July* 13*th*. it aſcended higher. On the 26*th* Day it expanded it ſelf ſo powerfully, as to ſeparate the Receiver and it's Cover, the Smell of it being acid. So that Air may be drawn out of Bread by ſuch a *Menſtruum* as Water.

EXPERIMENT II.

July the 11*th*. Bread being burnt by a Burning-Glaſs in *Vacuo*, yielded Air, which came from it with an Exploſion; whence we may gueſs, that could Air be ſeparated more eaſily from it, it would produce very conſiderable Effects.

EX-

EXPERIMENT III.

Septemb. 22.

I Enclos'd in a Receiver, Eight Ounces of dry'd Grapes, bruis'd in 7 Ounces of Water, the Receiver being large enough to contain 22 Ounces. *From Grapes.*

Septemb. 23.

Tho' the Receiver was cover'd with Water all Night, the Mercury was rais'd two Inches.

Septemb. 30.

In ſeven Days it was rais'd thirteen Inches.

Octob. 5.

In five Days more it was 25 Inches high.

Octob. 18.

The Mercury aſcended ſlowly, ſome Air making it's way out of the Receiver. Grapes without Water did not yield Air ſo plentifully. *See Art. IX. Exp. I.*

EXPERIMENT IV.

July 12.

I Shut up 10 Ounces of Raiſins of the Sun bruis'd, in as much Water as was ſufficient to make them ferment. *From Raiſins.*

July 14.

In 48 Hours rais'd the Mercury ten Inches; at Night the Mercury was 5 Inches higher; the next Day it was almoſt as high as when buoy'd up by the *Atmoſphere.*

July 16.

In the Morning the Receiver and it's Cover were ſeparated by Air, which got through the Water which the Receiver was cover'd with. The ſame Raiſins were ſhut up in *Vacuò* again.

July 18.

In the Morning the Air broke out.

July 19.

They were encloſed in the empty Receiver.

July 21.

The Receiver was ſo full of Air, that ſome of it forced it's way out; and they were incloſed in the exhauſted Receiver again.

July 22.

The Receiver was almoſt full: The 23*d* in the Morning it forced it ſelf out. When the Parts of the Water have work'd upon Grapes 5 or 6 days, they yield Air very faſt, tho' at the firſt they do not.

EXPERIMENT V.

Auguſt 13. 1677.

From Plumt. PLums were ſhut up in one Receiver, and Pears in two others.

Auguſt 16.

They were all full of Air, and one which contain'd Pears, and lay open to the Sun-Beams, rais'd the Cover in 24 hours.

EX-

EXPERIMENT VI.

Octob. 16. 77.

I Encloſed two Ounces of bruiſed Grapes in a Receiver large enough to hold 20 Ounces of Water.. *From the ſaid Grapes*

Octob. 17.

The Mercury was raiſed half an Inch.

Octob. 18.

The Mercurial Cylinder was raiſed half an Inch more. The 20*th* it encreaſed 2 Inches. The 22*d* 4 Inches. The 27*th* near 6 Inches.

Jan. 2. 78.

It was not quite 10 Inches high.

Octob. 16. 77.

Three Ounces of bruiſed Grapes being included in an exhauſted Receiver, large enough to contain 30 Ounces of Water, with half an Ounce of Spirit of Wine.

Octob. 17.

The Mercury did not aſcend much.

Octob. 18.

It was not an Inch high.

Jan. 2. 18.

The Receiver was quite full, and ſome of the Liquor as it was poured out, produced Bubbles in ſome Turpentine about the Orifice, which broke outwardly. Tho' Spirit of Wine promotes the Generation of Air in *Vacuo*, yet in the open Air it hinders it. See the II. VIII. and XIV. *Exp. Art.* II.

EXPE-

EXPERIMENT VII.

July 19. 78.

From Muſt. MUST expreſſed; bruiſed Grapes were put into a Receiver, when it was 10 Months old.

The 21. The Mercury was no higher.

23. It was raiſed 3 Inches.

24. Raiſed 5 Inches.

25. In the Morning it was 104, in the Evening 137 and the *Muſt* made its way out.

26. More *Muſt* got out. The Air was further expanded, but the Mercury was ſuſpended at the ſame heighth.

27. The Screw being left open, half the *Muſt* got out: From thence it appears, that by keeping Grapes for ſome time, their Fermentative Virtue becomes more powerful.

EXPERIMENT VIII.

Jan. 30.

From boil'd Apples. BOiled Apples being put into Receivers, with, and without Sugar, they both preſently filled them full of Air.

Jan. 31.

Raw Apples being ſhut up in Receivers, in one of which was put a third part of Sugar, and the other without.

Feb. 10.

The former had yielded ſome Air.

Feb. 14.

The raw Apples and Sugar rais'd the Mercury 30 Inches: Thoſe which were boyled raiſed it two

two Inches: In the other Receivers we had no Air generated,

Feb. 18.

In the Receiver in which the raw Apples and Sugar were encloſed, the Mercury was raiſed 56 Inches. The Boiled Apples and Sugar raiſed it 3. The raw Apples had yielded little; but in that which was almoſt full, the Apples were very little Fermented, but of a very pleaſant Taſte.

Feb. 21.

The Cover was broke, and the Apples and Sugar had loſt ſome of their Juice, but they were not Rotten.

March 1.

In the great Receiver in which raw Apples were ſhut up, the Mercury was rais'd 25 Inches: In the little One not above 7. Where Boiled Apples and Sugar were contained it was raiſed 9 Inches.

March 8.

In the large one it was 29. In the leſs 22½. That where the Boiled Apples were, ſtayed at 9 Inches.

March 17.

Some Juice got out of the large Receiver: In the leſs the Mercury ſtood at 67 Inches; and the boiled Apples and Sugar raiſed it 15 Inches.

From whence it appears, that the Sugar, and the largeneſs of the Receiver as well as the Crudity of the Fruit contributed to the Production of Air.

AR-

ARTICLE II.

Several ways to hinder the Production of Air.

EXPERIMENT I.

Decemb. 20. 78.

From Dough. DOugh made without Leaven; but with the ſame Meal with Bread-Corn, being enclos'd in a Receiver, where the Heat of a Fire kept it warmer than at *Midſummer*, in 10 hours it yielded no Air: So that if Dough be once too cold it hinders it's Fermentation for the future, which I the rather believe, becauſe Dough being ſhut up in the Summer preſently generated Air.

EXPERIMENT II.

May 23.

THree Ounce of Dough Leaven'd being enclos'd in a Receiver large enough to hold 50 Ounces of Water; I put Spirit of Wine to it.

May 24. The Mercury was Three Inches high.
26. The change was ſmall.
27. None at all.
29. None at all.
June 2. It aſcended a little.
14. Not at all.

Decemb.

Decemb. 14.

Being taken out it ſmell'd ſubacid: And being put into an Empty Receiver it ſwell'd ſo much as to take up twice as much ſpace as before with a gentle Ebullition.

May 23.

The ſame Quantity being of Dough ſhut up without Spirit of Wine.

May 24. The Mercury was 19¼ Inches high.

May 26. It's Heighth was 38.

27. No alteration.

Decemb. 14.

It continued at the ſame Heighth; and the Dough ſmell'd ſubacid: From whence it appears, that Spirit of Wine prevented the Generation of it in the laſt Experiment.

EXPERIMENT III.

Auguſt 29.

PEars, and a Mercurial Gage being clos'd up in a Receiver fill'd with Water, ſuch a Quantity of Air was preſſed in as was able to raiſe the Mercury 26 Inches higher than it us'd to be. In a little time they were all made like a Pultis for Conſiſtence. *From Pears.*

Aug. 30.

In 24 hours the Mercury was depreſs'd an Inch and an half.

Aug. 31.

It remain'd at the ſame Heighth.

Sept.

Sept. 1.

They began to yield Air, the Mercury being rais'd to 27 Inches.

Sept. 2.

In 24 hours it was rais'd 8 Inches higher.

Sept. 3.

The Heighth of the Mercury was 17 Digits higher, the heighth being 52 Inches.

Sept. 4.

The Mercury was buoy'd up 7 Inches further, reſted at 59 Inches.

Sept. 5.

The heighth of the Mercurial Tube was 64 Inches: And a Pear broken in the Receiver was turned Black.

Sept. 6.

It was rais'd 3 Digits and ¼ higher than what is uſual.

Sept. 7.

It was 3 Digits lower, and reſted again at 64 Inches.

Sept. 8.

This day the Mercury ſubſided to 58 Inches.

Sept. 9.

It was rais'd up 3 Digits higher again, and was ſuſpended at 67 Digits.

Sept. 10.

In 24 hours it was rais'd 1½ higher, being ſuſpended at 69 Inches.

Sept. 11.

It deſcended to 67 Digits again, the Night being very cold.

Sept. 12.

No Alteration happen'd at all.

Sept.

Sept. 13.

It ſubſided further to 64 Digits, the Cold was ſharper.

Sept. 14.

It was 70 Digits high.
Sept. 16. It ſubſided to 69.
19. It ſtood at the ſame heighth.
Sept. 20. It was rais'd again to 71.
23. It ſubſided to 69.

Octob. 1.

It was buoy'd up again to 75 Digits.

Octob. 3.

On the 2 there was no alteration: To Day it ſtood at 70, the Weather being exceeding cold.

Octob.

Yeſterday the Mercury remain'd at the ſame heighth; but this Day being Rainy it roſe again to 75.

Octob. 7.

The Weather being the ſame, the Mercury was at a ſtand.

Octob. 10.

This Day it ſubſided to 69 Inches, the Rainy Weather continuing.

Octob. 12.

To Day it was Depreſs'd to 65 Inches: Cold Weather coming on again.

Octob. 13. It was 64 Inches high.
14, 15. It was 69, 74 Digits high.
24. It was 68 Inches. The Seaſon being cold.
Nov. 2. It was 64. The Cold more violent.
Nov. 5. The Mercury was 80½ Inches high. The Cold more moderate.
2. It was 65 Inches high: It was ſharp froſty Weather.
27. It was 68 Inches high. A Thaw coming on.
Dec. 6. It was 61 Inches high. The Weather being very Froſty.

From

From the former Experiment, it appears, that Fruits yield not Air plentifully when violently compreſs'd, in the Air: The Air afforded, when they are compreſſed not being $\frac{1}{8}$ of what they yield in the Empty Receiver. But that the Cold might concur to hinder the Generation of Air will be evident from the following Experiment.

EXPERIMENT IV.

Feb. 22. 77.

From Paſte. TEN Ounces of Paſte being included in a Receiver which was large enough to hold 22 Ounces of Water, I impreſs'd Air enough into it to ſuſtain 73 Inches of Mercury above the length of a Cylinder which the Weight of the Atmoſphere is able to bear up. In two hours there was no ſenſible Alteration.

Feb. 23.

In 18 hours the Mercury was rais'd 7 Inches. And in 6 hours more it aſcended 8 Inches higher, being buoyed up to 83 Inches.

Feb.	24		90				Water ſeemed to be expreſſed out of the Paſte.	
	25		97					
	26	It	101	Inches	*March*	2	It was	120 Inches.
	27	was	105	high.		3	rais'd to	121
	28		$107\frac{1}{2}$			4 & 5	It remained at 121 Inches.	
March.	1		112					

March 8.

Upon a Thaw the Mercury aſcended 4 Inches and reſted at 125 Digits.

March 10.

It roſe 6 Digits higher, being ſuſpended at 131 Digits.

March

March 21.

The Seaſon being ſo long Cold, no Air was generated, except that in the three laſt Days the Mercury was rais'd 7 Inches, and reſted at 138 Digits.

April 4.

One of the Iron Wires made uſe of to ſtraiten the Receiver, was broke, and the ſides of the Receiver ſtarted out of their Places 4 or 5 Foot.

From whence it appears that Cold and compreſſion hinder the Generation of Air.

EXPERIMENT V.

March 1. 77.

TWO Raiſins of the Sun being bruis'd were ſhut up in an exhauſted Receiver with Six Ounces of Vinegar: It afforded Bubbles plentifully.

March 2.

It ſtill yielded Bubbles; but the Mercury was not rais'd half an Inch.

March 25.

The Vinegar ſeem'd to contain Bubbles; but the Mercury was not rais'd an Inch.

So that Vinegar hinders Fermentation and the Production of Air.

EXPERIMENT VI.

April 7.

HAving put 10 Ounces of Paſte into a Receiver able to contain 22 Ounces, of Water, as much Air was preſs'd in as ſuſtain'd Mer- *Paſte included in a Receiver.*

cury above its uſual height 128 Inches.

In Six hours it was rais'd four Inches, being ſuſtain'd at 132 Digits.

April 8.

In 16 hours it aſcended 9 Inches higher, but for nine hours after it reſted at 141.

April 9.

Some Air broke out in the Morning; the Mercury ſubſided to 130 Inches, therefore thruſting in as much Air as rais'd it to 141 I clos'd it it up with a Screw.

Apr. 10	It was at	151	Digits.		*April* 14	It was at	183	Digits.
11		158			15		183	
12		168			16		187	
13		176			17		191	

April 27.

Eight Days it's Station was unalter'd, but the two laſt it was rais'd 7 Inches, being rais'd to 198 Digits.

April 30.

So much Air being let out, that the Mercury was rais'd but 50 Inches above it's uſual height, to try whether the compreſs'd State of that Air hindred it from expanding, the remaining Air being pinned up preſently rais'd the Mercury ſenſibly, and 3 hours after the Mercury was rais'd to 62 Digits from 50. In five hours ſpace after roſe 1½.

May 1.

In 15 hours it rais'd only an Inch.

May 3.

On the Second it was at a ſtand; to Day it was rais'd 1½.

May

May 4.

The Mercury aſcending no higher, I let the Air go; and the Screw being ſet again, in five Minutes the Mercury was rais'd two Inches.

May 7.

In 3 Days it was rais'd 2 Inches higher.

May 8.

In the two laſt Days it was rais'd ½ an Inch. And the maſs being ſhut up *in Vacuo*, in 5 hours the Mercury was buoyed up an Inch.

May 21.

It had not been rais'd 3 Inches yet.

May 30.

It reſted at 4 Inches and ½.

From whence it appears, that all the Air that Paſte will afford, may be obtain'd from it, tho' it be compreſs'd; yet it is hindred in ſome Meaſure, till that Preſſure is taken off. And from hence it appears, that Air may be generated by repeated Turns and Reciprocations; and that it is more ſlowly generated in compreſs'd, than in free Air, it uſually yielding all that it will, in two or three Days time.

EXPERIMENT VIII.

July 30. 77.

Artificial Air.

HAving included Plums and Apricocks cut aſunder in a Receiver, I preſs'd ſo much Artificial Air of Cherries into them, as rais'd 64 Digits of Mercury. *Plums and Apricocks.*

August 1.

They yielded no Air, but became Yellow, as if too ripe.

August 3.

The Mercury was rais'd a little higher, and a whole Apricock, appear'd full of Drops of Water.

August 7.

The whole Apricock grew ſofter; and the Mercurial Cylinder 59 Inches taller than it's uſual Length.

August	8		61		*April*	13		78	
	9	It	65	Digits		14	It	80	Digits high.
	10	was	71	high.		15	was	80	
	11		74			16	And till the 22*th* it reſted at the ſame height.		

The 24*th* it was 77 Inches high.

On the 29*th* I open'd the Receiver, and found that the Fruit was well Colour'd and ſmell'd Subacid, the Fleſh being Spongeous; It emitted ſeveral Bubbles when firſt it was freed from the ambient Preſſure.

July 30. 77.

Common Air.

The ſame Fruit being conveyed into a Receiver with Common Air, ſome being cut and others whole.

July 31.

The Mercury was rais'd 8 Inches high.

August 1.

At ſix a Clock in the Evening the Mercury was rais'd 20 Inches.

Auguſt

Auguſt 3.

The Fruit was much more firm, than thoſe Included with Artificial Air. The Mercury was rais'd to 35 Inches.

Auguſt 4.

The Mercurial Cylinder was rais'd to 42 Inches.

Auguſt 6.

The Apricock appear'd unalter'd: The Mercury ſtood at 57 Inches.

Aug. 7	It	81	Digits	*Aug.* 9	It	113	Digits
8	was	95	high.	10	was	124	high.

The Apricock began to turn Yellow: But did not in the leaſt appear Moiſt.

Aug. 11	It	131	Digits	*Aug.* 15	It	171	
13	was	157	high.	16	was	171	
14		163					

17 And for ſome time after it ſtood at the ſame height.

Aug. 27 It was 182 Inches high.

29 The Receiver being open'd, the Apricocks were more Acid and leſs grateful to the Taſte, than thoſe in factitious Air: The Pulp was well Colour'd, but Spongy; they yielded Bubbles as the others did.

From this Experiment, we may be induced to think that the Artificial Air, hindr'd the Apricock enclos'd with them, from yielding Air; yet it enriches their Colour and Firmneſs; and is good to preſerve their Taſte.

EXPERIMENT VIII.

Grapes without Spirit of Wine.

AN Ounce and an half of unripe Grapes bruis'd being enclos'd in a Receiver, capable of holding 10 Ounces of Water.

Oct. 11	The Aſcent of	*Octob.* 26		5½	
12	the Mercury was	27		6	
	ſmall.	30		6⅓	
13	It was ½ an Inch.	*No.* 2		7½	
17	It was 1 Inch.	6		9	
18	It was 1 ½.	8		10	
19	Near 4 Inches.	9	It	13	Inches
20	The ſame, but	12	was	15	high.
	their ſurfaces	14		17	
	ſeem'd mouldy.	18		23	
21	It was 4½ Inches.	21		26	
22	The ſame, the	*Dec.* 8		36⅓	
23	ſurface ſeem'd	12		39	
24	more mouldy.	27		39	
		Jan. 6		36	

The Air made it's way out.

Octob. 10. 677.

Grapes with Spirit of Wine.

The Experiment being made with another Receiver into which was put 2 Drachms of Spirit of Wine along with the Grapes.

Oct. 11	The Mercury un-	*Oct.* 17	The Aſcent was
12	alter'd.		ſmall.
13		18	Not ¼ of an Inch.
		19	It roſe but little.

Jan.

Jan. 6.

The Grapes all this time afforded no Air: So that Spirit of Wine hinder'd their Fermentation.

EXPERIMENT IX.

HAving conveigh'd a Peach into a ſmall Receiver, and ſo much Spirit of Wine as was juſt able to afford Vapours to riſe about it.

March 28. 78.

It had the ſame Colour but was the leſs Firm: It had almoſt wholly contracted the Taſte of the Spirit of Wine, but yielded no Air.

EXPERIMENT X.

Air with Spirit of Wine.

I Conveigh'd 5 Peaches into a Receiver with as much Spirit of Wine as was ſufficient to raiſe Vapours about them.

Octob.	18	The Mercury aſcended not.			*Nov.*	6	It was 14 16	Digits.
	20	It was $3\frac{1}{2}$ Inches.				12		
	21	It was	$5\frac{1}{2}$	Inches high.		14 16	The ſame.	
	22		$7\frac{1}{2}$		*Dec.*	8	It was 18 $19\frac{1}{2}$ $20\frac{1}{2}$	
	23		9			16		
	26		$9\frac{1}{2}$			27		
Nov.	2		12		*Jan.*	6	It was 23.	
					March	8	It was $31\frac{1}{2}$.	

Octob. 17.

Air without Spirit of Wine.

Five Peaches being ſhut up in a Common Re-

ceiver without Spirit of Wine; *Octob.* 18 it aſcended not.

Octob. the 20*th* The Mercury was 5 Digits.

Octob. 21		8	*Nov.* 12		20		
22		10	14		20		
23	It	10	16	It	21		Digits
26	was	12	*Dec.* 8	was	26		high.
Nov. 2		15	16		26½		
6		17½	27		28½		

Jan. 6. 78 It was 32 Inches high.
March 28 It was 33½.

April 15.

Liquor broke out, and the Air after it: From this Experiment it appears that the Vapours do not hinder Fermentation ſo much as Spirit of Wine it ſelf.

EXPERIMENT XI.

Paſte with Leaven.

HAving clos'd an Ounce and a half of Leaven'd Dough in a Receiver with ſo much Air as was able to bear up 23 Ounces ½ of Water.

April 28.

The Mercury in the Gage was 2¼ of an Inch high.

April 3.

It was 3¼ of an Inch high.

May 4.

The Mercury ſubſided, and the Paſte was Mouldy, It was rais'd 2¾ high.

May

May 6		2¼		*May* 17		4½
8	It	3		20	It	5
10	was	3⅓		24	was	6
14		4		28		8
June 2		9		*July* 5	It	13⅓
6	It was	10		19	was	15
41		11⅓				

April 27. 78.

Paſte without Leaven.

An Ounce and a half of Paſte without Leaven being contain'd in a Receiver large enough to hold 23 Ounces ⅓ of Water. *Without Leaven.*

April 29.

In the Afternoon it aſcended ¼ of an Inch.

April 30.

There was no Alteration.

May 4.

It aſcended ſlowly and the Paſte turn'd Mouldy.

May 6.

It was about 4 Inches high.

May 8		5⅓		*May* 24		16⅓
10		7⅓		28		18⅓
14	It was	10⅓		*June* 2	It was	20⅓
17		12⅓		6		21⅓
20		13⅓		14		25

From whence it appears, that Leaven hinders Fermentation and the Production of Air.

EX-

EXPERIMENT XII.

May 23.

Paſte with Spirit of Wine.

AN Ounce and a half of Paſte, on which Spirit of Wine was pour'd, being ſhut up in a Receiver.

May 24*th.* The Height of the Mercury was
1 Inch.
26 It was near 2.
27 It was near 2½.
31 No Alteration.

June 1, 6, 10 | It was | 3½, 4, 4½ | Digits high.

July 19 No Variation.

Decemb. 14.

The Receiver being open'd, the Paſte ſmell'd ſubacid.

May 23.

Paſte without Spirit of Wine.

Without it. An Ounce and a half of Paſte being put into a Receiver large enough to contain 25 Ounces of Water, without an Addition of Spirit of Wine.

May 24.

The Mercury did not aſcend.

May 26, 27, 28, 29, 31, *June* 2 | It was | 3, 4½, 5½, 7, 9½, 12 | Digits high.

June 6, 10 | It was | 17, 22 | Digits
July 4, *July* 19 | It was | 30 | Digits

It was about the height of 30 Digits. The Air broke out.

Decemb. 14.

The Mercury was rais'd 15 Digits again; The Receiver being open'd, the Paſte was very acid.

From

From theſe Experiments it appears, that Spirit of Wine prejudices the Production of Air; And it likewiſe hence is evident, that Paſte which is made without Ferment, will in time yield as much Air, as that prepar'd with it.

EXPERIMENT XIII.

Octob. 11.

NEW Ale was put into one Receiver, ſo that the whole Cavity was taken up with it, and another Receiver was likewiſe fill'd with the ſame Liquor, except a ſmall Part of it's Cavity which contain'd Air. *New Ale enclosed in a Receiver.*

Octob. 12.

In the Receiver exactly fill'd, the Mercury was rais'd a little; the other had it's Cover burſt, and the Ale was conveighed into another large enough for the Purpoſe.

Octob. 13.

In that wholly fill'd, the Mercury was 12 Digits high; In the other it was rais'd 13 Digits.

Octob. 14.

The Mercury in the full Receiver was 13 Inches, and the other 18. In the Evening the height of the Mercury in the full Receiver was 22 Inches, and in the other 20.

Octob. 15.

The Height of the Mercury in the full Receiver was 42 Inches: In the other 26.

The Bubbles which before appear'd in the full Receiver diſappear'd; And the Air in the Gage poſſeſſed a larger Space than before.

In

In the full Receiver the Height of the Mercury was

Octob. 16	60			*Octob.* 16	30		
18	90			18	40		
22	90			22	42	In the other.	
23	108	Inches.		23	50	Inches.	
26	108			26	60		
28	138			28	63		

The Bubbles appear'd again.

Novemb. 8.

When the Receiver was open'd the Ale ſeem'd ready to fly into Froth, except the Orifice was preſently ſtopp'd again; It's Taſte was very Pungent: As the Hole in the Gage is open'd or ſhut, the Mercury will deſcend or aſcend.

Novemb. 9.

Almoſt the ſame *Phænomena* were taken notice of when the other Receiver was open'd.

From this Experiment it appear'd, that tho' the Ale ſooner ferments when Air is permitted to be with it, than when it is not; yet the Ale in ſuch Receivers, at the laſt expands more violently.

EXPERIMENT XIV.

June 27.

Peaſe with Spirit of Wine.

GReen Peaſe and Spirit of Wine being put into the Receiver, by ſome Air that got in accidentally, the Mercury was rais'd 18 Inches: to prevent which a ſecond time, the Receiver was cemented, and made firm with Turpentine.

The

June 30.

The Height of the Mercury did not vary.

July 7.

No Air was generated in the higheſt Degree of Heat.

Peaſe without Spirit of Wine.

The ſame Quantity of Peaſe being put into the Receiver, as in the laſt Experiment, without Spirit of Wine.

June 28.

At night the Height of the Mercury was 5 Inches.

Jun. 29	It was	10	Digits high.		*July* 5	It was	26		Digits high.
30		16			7		30		
July 1		19							

July 8. The Air got out of the Receiver, it being too much filled.

From which it appears, that Spirit of Wine hinders the Generation of Air in Peaſe.

ARTICLE III.

The Effects of Artificial Air, are different from the Effects of common Air.

EXPERIMENT I.

June 19. 77.

CHERRIES being ſhut up in an evacuated Receiver; the Mercury was rais'd in 6 hours 5 Inches ½. *Cherries inclosed in a Receiver.*

The

June 20.

The Mercury was rais'd 3¼. At night it was 2.

June 21	It was rais'd	1 1/2	*June* 26	It was	3
22		1 1/2	27		3
23		2	28		5
24		1 1/2	30		1 1/2
25		1 1/2			
July 1	It was rais'd	3	*July* 4	It was rais'd	2 1/2
2		4	5		3
3		2			

It was 45 Inches high, but the Air being conveighed into another Receiver, It ſubſided to 25 Inches.

July 6	It roſe	4	*July* 10	It roſe	6
7		5 1/2	11		12
8		5	13		7.
9		5			

July 13. The Mercury being rais'd 3 Inches, was ſuſpended at 92 Inches, and the Air being conveighed into another Receiver, was 50 Inches high.

July 14	It was rais'd	14	*July* 25	It roſe	8
15		11	26		9
16		13	27		4
17		5	28		5
18		9			

The

The	19	It was ſubſided from 102 to 92 Inches; Part of it being conveighed into another Receiver.			30	It aſcended ten Inch. the Length of the ſuſpended Cylinder being 98 Inches. And part of the Air being conveighed into another Receiver, it ſtood at 64.		
	20	It aſcended 15.						
	22	Air getting out, it ſubſided to 63 Inches $\frac{1}{2}$.	*July*	31	It roſe	6 9 4	Inc.	
			August	1				
				2				
	23	It aſcended to 12 $\frac{1}{2}$.		3	It being removed into another Receiver was 68 Inches high.			
	24	It aſcended 4, the height of the Cylinder being 79 But the Air being remov'd into another Receiver it ſtood at 62.		4	It being removed, ſubſided to 54 Inches.			
				6	It roſe	7 4 0 3	In.	
				7				
				8				
				9				

The Receiver being open'd; the Cherries were almoſt inſipid, being of a whitiſh Colour, and the Pulp ſpungy.

From this Experiment it appears, that, tho' Cherries are capable of yielding Air, yet the Production of it is not very regular.

EXPERIMENT II.

July 13*th* 67.

CHerries being encloſed in a Receiver, together with as much Air, obtain'd from Cherries put up in another Receiver, as was able to ſuſtain a mercurial Cylinder 50 Inches. *Cherries enclos'd in a Receiver.*

It

July 15.

It was rais'd two Inches higher, tho' the day before there was no Variation in it's Height.

July 16		1 1/8	*July* 27		2 Some Air
17	It was	1 1/8	30	It was	got out.
26	rais'd	1 8	31	rais'd	7
		Some Air got out.			9 Inches.

August 1st.

It ſtopped at the height of 61 Inches, ſome Air making it's way out.

Aug. 27.

The Air being wholly vaniſh'd; I took out the Cherries, which retain'd their Colour without Putrefaction: Their Taſte was acid, and the Pulp was full of Cavities like fermented Paſte.

From this and the foregoing Experiment compar'd, it appears that Fruits yield leſs in artificial than common Air, and conſequently, their natural State is longer preſerv'd.

EXPERIMENT III.

Septemb. 10th 77.

Common Air.

Grapes incloſed in a Receiver.

SIX Ounces of unripe Grapes being ſhut up in a Receiver, which was large enough to hold 25 Ounces of Water, with common Air, I ſhut up the Receiver firmly with a Screw.

Sept.

21

Septemb. 11 The Mercury roſe not in the leaſt.

12 It was about an Inch high.

13		$3\frac{1}{2}$	*Sept.* 18		16
14		7	19		18
15	It was rais'd to	10	20	It was rais'd to	20
16		$12\frac{1}{2}$	21		22
17		14	22		$23\frac{1}{2}$

Septemb. 23 It was rais'd to 27 Inches, no Alteration being obſerv'd in the Grapes.

Septemb. 24 It was 30 Inches high.

25 It was 31. The Colour of the Grapes being turn'd yellow.

Septemb. 26	It was rais'd to	$32\frac{1}{2}$	*Sept.* 29	It was rais'd to	35
27		34	30		

Octob. 1 The Mercury was 35 Inches high.

2			*Octob.* 10		35
0	It was	36	13	It was	$32\frac{1}{2}$
6					

None of the Air made it's way out; but the Cold encreaſed.

Novemb. 9 The Mercury had neither aſcended nor deſcended.

Decem. 19 The Air was loſt.

20 The Grapes took out of the Receiver were firmer than before, their Taſte and Smell diſcovering them to be mouldy.

Septemb. 10. 77.
Factitious Air.

Having included 2 Ounces of unripe Grapes in a Receiver which was large enough to contain 8 Ounces of Water, and as much of factitious Air of Pears as sustain'd a mercurial Cylinder of 10 Digits.

Sept. 11.

The Mercury subsided to 8 Digits.

Sept. 12.

It ascended 3 Inches.

Sept. 13	It rose	16		*Sept.* 15	It rose	23
14	to	20		16	to	24

Sept 17.

It was sustain'd at 28 Inches; the Colour of the Grapes being turn'd Yellow.

Sept. 18		29	*Sept.* 23	It	35
19	It	30	24	was	20
20	was	31	Some Air got out. The		
21		38	Grapes were Yellow.		

Sept. 24		21	*Sept.* 27		22
25	It	22	29	It	27
26	was	little Variation.	30	was	28

Oct. 1 & 2		28	*Nov.* 9		13. Some Air
5	It	30		It	made it's
6	was	31		was	way out.
10		31½	19		29 Inches
13		31			high.

Dec.

Dec. 20.

The Grapes had acquir'd a greater degree of Firmneſs, The Taſte and Smell being not leſs grateful than before.

In which Experiment the firmneſs ſeems to be effected by an exhalation of the Spirits; and it hence likewiſe appears, that Factitious Air may preſerve the Taſte, tho' it cauſes a change in Colour.

EXPERIMENT IV.

July 18.

HAving enclos'd two Pieces of Oranges, the one with Common Air, and added as much Factitious Air of Cherries as was ſufficient to bear up 12 Inches of Quickſilver, and the other without any addition to the Air contain'd in the Receiver. *Artificial Air from Oranges.*

July 20.

The latter ſeem'd Mouldy; the other not appearing to have undergone any Change.

July 23.

The Orange contain'd in the Factitious Air was unalter'd, the Mouldineſs of the other being encreas'd.

July 26.

That in the Common Air ſeem'd Putrid; as likewiſe the other did, but without Mouldineſs.

Auguſt 1.

No farther Alterations appearing in the Oranges, I open'd the Receivers, and obſerv'd that in the Artificial Air, which held the Mercury 26 Inches high, was well Taſted and Firm; only the Top of the Rind had loſt a little Juice;

that in the other Reciver ſeem'd Rotten, except the Rind.

It may be here obſerv'd, that Factitious Air of the Cherries, hath different Effects on ſeveral Fruits.

EXPERIMENT V.

July 20. 76.

Factitious Air.

Artificial Air from Beef.

HAving compreſs'd Air made of Cherries in a Receiver with a Piece of Beef, ſo that it bore up a Cylinder of Mercury 27 Inches high.

July 21, 22, 23, 25, 26 | There was no conſiderable Change in the Height of it.

The Receiver and Cover were ſeparated; the Fleſh Stunk.

July 20. 76.

Common Air.

Beef being ſhut up with Common Air: The Mercury was rais'd.

July 21		0
22		1 Inch.
23		$5\frac{1}{2}$
25	to	$9\frac{1}{2}$
26		$14\frac{1}{2}$ towards Night 18.
27		$21\frac{1}{2}$ towards Night 25.
28		The Air got out.

Hence it appears, that the Artificial Air of Cherries, hindred the Generation of it from Fleſh.

EXPE-

EXPERIMENT VI.

March 14. 76.

Common Air.

TWO Onions being enclos'd with Common Air in a Receiver. *Artificial Air from Onions.*

March 28.

The Mercury on the Sixteenth was depreſs'd ¼ of an Inch, but after was buoy'd up 2¼. And the Air geting out, the length of the Roots was increas'd. *April* 28.

They were putrifi'd and corrupted.

May 9.

The Mercury neither aſcended nor ſubſided, but the Roots were putrifi'd.

March 17. 76.

Factitious Air.

Onions bing included with Air obtain'd from Paſte. *March* 28.

They took Root juſt as they uſually do in Common Air.

April 28.

The Extremities of the Roots began to putrify, perhaps becauſe the Artificial Air might be moiſter: The Mercury Aſcended 9 or 10 Inches.

May. 18.

One of them began to corrupt: From whence it appears, that Vegetation is not hinder'd by artificial Air; and it likewiſe appears, that the Quantity of Air is increaſed.

EXPERIMENT VII.

August 25.

Common Air.

Artificial Air from Grapes.

SIx Ounces of Grapes being ſhut up in a Receiver large enough to contain 25 Ounces of Water.

Aug. 26	It's Aſcent ſcarce diſcernible.	28	It's Height was	$1\frac{1}{4}$
27	1 Inch.	29		

Aug. 30.

The Mercury ſubſided a little; the Grapes were not equally alter'd, as in Artificial Air of Pears.

Aug. 31.

The Grapes being open to the *Atmoſphere.*

Septemb. 7.

Their pungent Taſte was ſomething abated, tho' they retain'd their Colour.

Aug. 25.

Factitious Air.

Two Ounces of Grapes being ſhut up in a Receiver, large enough to hold $8\frac{1}{2}$ of Water, ſo much Air of Pears was thruſt in, as was able to raiſe it 15 Inches.

Aug. 26.

Some Air getting out, a ſupply was added, which rais'd the Mercury to 17 Inches high.

The

Aug. 27.

The Mercury ſubſided to leſs than 16 Inches; towards night it aſcended again to 17 Inches.

Aug. 28	It roſe	19	*Aug.* 31	It roſe	23⅓
29	to	21	*Sept.* 1	to	24
30		22	2		24

and 4 thay acquir'd a Yellowneſs. 5. Air got out.

Sept. 7.

The Grapes were inſipid, and of an ungrateful Taſte.

From this Experiment we may argue for the Power of Artificial Air in changing Colours: It promotes the Generation of Air, and preſerves Taſtes.

EXPERIMENT VIII.

Aug. 2. 76.

Factitious Air.

A Gilliflower being encloſed with Air of Paſte in a Receiver. *Artificial Air from Gilliflowers.*

Aug. 4.

It was moiſt, and alter'd it's Colour.

Aug. 9.

It was in ſome meaſure alter'd.

Aug. 12.

Their Moiſtneſs increas'd gradually without Mouldineſs.

Aug. 31.

It was not ſo freſh as thoſe in *Vacuo*.

Aug. 2.

Common Air.

Being enclos'd with Common Air.

Aug. 4.

It was unalter'd.

Aug. 9.

It was wet, and almoſt Colourleſs.

Aug. 12.

It was very Mouldy.

Aug. 4.

Vacuum.

Two Gilliflowers being ſhut up in *Vacuum.*

Aug. 4.

They ſeem'd moiſt. But in a year after underwent no Alteration. From whence it appears, that factitious Air renders Colours more ſubject to change.

EXPERIMENT IX.

July 24.

Common Air.

Artificial Air from Apricocks and Plums.

Apricocks and Plums being incloſed in a Receiver.

July 28.

There was no Change in the Fruit, but that one Plum which was cut in pieces, was a little mouldy.

Aug. 11.

The Colour Taſte and Conſiſtence of the Fruit were all very acceptable.

July 24.

Artificial Air.

The ſame Ingredients being ſhut up with ſo much Artificial Air of Cherries, as kept a Cylinder of Mercury up to 22 Inches.

It

July. 25.

It ſubſided 3 Inches, and roſe to 22 again towards Night.

July 26		It roſe		28		*July* 28		It roſe		36	
27		to		34½		29		to		40	

July 30 It roſe 44 Foot high. Thoſe Apricocks which were cut in pieces were moiſt, and began to diſſolve in Water.

July 31				51
Aug. 1		The Height was		60

Aug. 2 It was 65 Foot high. The Fruit being taken out, were of a grateful Taſte, and as far as they were immerſed in Water, very ſoft.

From whence it is evident, that the Air of Cherries haſtens Alterations in Colour, and Firmneſs in Apricocks.

EXPERIMENT X.

July 30.

PLums cut in pieces, being ſhut up in *Vacuo*, and likewiſe with Common Air; and in another Receiver with Common Air of Gooſeberries.

Aug. 2.

In the latter, they were unalter'd: In common Air they grew mouldy: In *Vacuo* they became ſoft.

Aug. 5.

In the Artificial Air, they became red, ſoft and moiſt; In Common Air black and mouldy, yet firm: In *Vacuo* they were near a Diſſolution.

Aug.

August 7.

They became ſoft in Common Air.

August 8.

They became red inſtead of Black: Artificial Air ſeems to promote Alteration.

EXPERIMENT XI.

Sept. 24.

Peaches ſhut up in a Receiver.

Five Peaches being clos'd in a Receiver, with Artificial Air of Grapes together with Common Air.

Sept. 25 The Mercury was 21 Inches high.

Sept. 26	It roſe	23		*Sept.* 29	It roſe	42
27		31		30		45
28	to	39		*Oct.* 1	to	48
				2		48

Oct. 3		52½		*Oct.* 30		61½	
5		52½	The Peaches were Wet.	*Nov.* 2		59	Very Cold.
6		58		6		61	A Thaw.
7	It roſe	58		7			A little heigher.
8	to	61		9	It roſe		At the ſame
11			A little higher.		to		height.
19		95		*Dec.* 9			In a Month it
25		61	Very Cold. The Cold abating it				gradually aſcended to 8
27			Aſcended.				Inches.

April 1.

It was 96. When the Receiver was open, as the Air broke out, it emitted ſeveral Bubbles; their Taſte and Colour were good, the conſiſtence of them was as if they had been boil'd: And in three hours time they were Rotten.

Bodies

Bodies corrupt leſs in a Mixture of Factitious and Common Air, than in the Latter it ſelf.

EXPERIMENT XII.

Auguſt 4.

FOur Pieces of Pear being clos'd with Common Air in a Receiver. *Pears enclos'd in a Receiver.*

Auguſt 6.

The Colour of this Fruit was equally alter'd as of others: The Mercury aſcended not.

Auguſt 7.

The Mercury aſcended a little, the Alteration in the Pears being ſmall.

Auguſt 8.

They were very little Alter'd; the Cylinder of Mercury was 4 Inches.

Auguſt 9.

It was $4\frac{1}{2}$.

Aug. 10	It roſe	6		*Aug.* 13	It roſe	16
11	to	10		4	to	20

The Pears grew ſofter.

Aug. 15	It	21	*Aug.* 8	The Air being
16	was	19		got out, and the Fruit
17	Air got out.			taken out, it was rotten.

Auguſt 4.

Other Pieces of the ſame Fruit being ſhut up with as much Artificial Air of Cherries as ſuſtain'd 23 Digits of Mercury above it's uſual height.

Auguſt 6.

The Colour of them was a little alter'd.

Auguſt 7.

They were almoſt all Rotten: The Mercury neither ſubſiding nor aſcending.

Auguſt

August 8.

They were in some Measure alter'd.

August 10.

They gradually became softer: The Mercury being rais'd 40 Digits.

Aug. 11	It rose	51	*Aug.* 15	It rose	73	It Descended, tho' no Air made it's way out.
13	to	61	16	to	
14		67			

August 17.

The Mercury was 67 Digits high: No Air got out.

August 18.

The Mercury subsided not: The Taste of the Fruit was Acid, and their substance very soft; the Air contain'd in the Receiver likewise, smelling very sharp.

August 4. 77.

Pieces of the same Fruit being enclos'd in a Receiver.

August 6.

They alter'd their Colour.

August 7.

A piece of a Pear became soft: and another in Artificial Air was putrid the Day before.

August 8.

They were all soft; and one was Mouldy.

August 9.

Their Rottenness gradually encreas'd.

August 11.

They were altogether Rotten and Mucid.

From

From this Experiment and the former it appears, that Rottenneſs is equally promoted, in included and open Air, tho' much faſter carri'd on in the Latter.

Auguſt 4. 77.

Several Pieces of Pears being ſhut up *in Vacuo.*

Auguſt 6 The height of the Mercurial Cylinder was 5 Digits.

Aug. 7	It roſe to	8		*Aug.* 13	It roſe to	20
8		10		14		23
9		12		15		25
10		14		17		28
11		16				

Auguſt 20.

They were not in the leaſt Chang'd till to Day; when being ſoft, the Mercury was at a ſtand.

Auguſt 26.

All things Remain'd as before.

From which Experiments it appears, how apt Artificial Air is to ſoften Fruit.

EXPERIMENT XIII.

Auguſt 21. 77.

SIX Apricocks being divided into Quarters, one Piece of each was inclos'd in a Receiver. *Apricocks ſhut up in a Receiver.*

Auguſt 22.

They ſeem'd Riper.

Auguſt 23.

One piece which touch'd the Water, acquir'd

Mouldineſs, the other beginning to putrify. The Mercury aſcended a little.

Auguſt 24.

Thoſe next the Water were not only Mouldy, but all Rotten.

Auguſt 25.

Putrifaction gradually became greater: The height of the Mercury was 7 Inches.

Aug. 26		15		*Sept.* 2		38
28		30		3		38 + A
29	It roſe	30	The Fruit	4	It	41 little.
30	to	33	was almoſt	5	roſe	43
31		38	diſſolv'd.	7	to	45
Sept. 1		38		8		46
				9		46

Sept. 22.

The Mercurial Cylinder vari'd little: The Fruit was almoſt diſſolv'd.

Octob. 1.

The Taſte of the Fruit which remain'd undiſſolv'd was ſubacid and grateful: The Mercury then ſtanding about 46 Inches high.

Auguſt 21. 77.

A Quarter of each of the ſame Fruit being plac'd in a Receiver, which was not ſufficiently guarded from the outward Air,

Auguſt 22.

They became as flaccid as if they were wither'd.

Auguſt 23.

Many were Rotten and Mouldy.

Auguſt 24.

They were wholly putrifi'd.

Auguſt.

August 21.

A Quarter of each of the Apricocks being ſhut up in a Receiver, and a ſufficient Quantity of Artificial Air from Pears added, as rais'd the Mercury 20 Inches.

August 22.

The Mercury ſtood ſtill, but became Riper than thoſe in open Air.

August 23.

The Alteration was not ſo great as in Common Air.

August 24.

They were unalter'd.

August 25.

They began to yield Air; but the Quantity was not diſcernible.

August 26.

They underwent no conſiderable Change.

August 28.

They began to be a little moiſt: Yet the Alteration they underwent was not ſo conſiderable as of thoſe in Common Air.

August 30.

The Mercury Roſe 30 Inches above it's uſual Height.

Aug. 31				*Sept.* 9			40
Sept. 1	It roſe	40		11	The		38
2	to			12	height		leſs,
3		45			was		33
8		49 +	A little.	13			

Sept. 14.

The Mercury ſubſided ſo far as to diſappear.

Sept.

Sept. 22.

It roſe again to 33 Inches: The Fruit was cover'd with a Mucor.

Octob. 1.

The Apricocks were well colour'd: But ſpongy and ſoft, and of a ſubacid Taſte.

Auguſt 21.

A quarter of each of the aforeſaid Fruit, being enclos'd with as much Common Air as was able to raiſe the Mercury 90 Inches above it's uſual height.

Auguſt 22.

The Receiver burſting with the Elaſticity of that Air, the Fruit was enclos'd with as much Air as rais'd the Mercury 60 Inches.

Auguſt 25.

New Air was added, the Fruit was not Mouldy.

Auguſt 26.

They were altogether Rotten and Mouldy.

From whence it appears that Corruption is quicker in Artificial, tho greater in Common Air.

ARTICLE IV.

The Effects of Air compreſs'd, different from the Effects of Common Air.

EXPERIMENT I.

March 21. 77.

TWO Onions being ſhut up with as much common Air, as was able to ſuſtain 60 Inches of Mercury. *Onions ſhut up in a Receiver.*

March 28.

They took Root like others in the Air, no more compreſs'd than that of the *Atmoſphere*.

April 28.

Onions ſhut up 8 Days ago, were mouldy: The Extremities of the Roots of thoſe in compreſſed Air, began to rot: And new Air being put in, rais'd the Mercury 69 Digits.

April 29.

Thoſe in the compreſſed Air were mouldy.

From this Experiment it appears, that Compreſſion hinders not Vegetation; and tho' Compreſſion ſeem'd to hinder Corruption at the firſt, yet upon an Intruſion of freſh Air, it was by that promoted.

EXPERIMENT II.

May 9.

Tulips and Lark-Spurs incloſ'd in a Receiver.

HAVING inclos'd an equal Proportion of Tulips and Lark-Spurs together in two Receivers; as much Air was ſqueez'd into one as was able to raiſe Mercury 70 Digits.

May 11.

Two Tulips in the common Air uncompreſs'd, were mouldy.

May 12.

Another in the uncompreſs'd Air became mouldy.

May 14.

All the Tulips and one Lark-Spur became mucid; One Tulip in the compreſs'd Air being likewiſe mucid.

May 17.

Three in the compreſs'd Air acquir'd a Mucidneſs, yet not ſo much as thoſe in the Air uncompreſs'd: Two of the Lark-Spurs in uncompreſs'd Air were fnew'd, but thoſe in the compreſs'd Air, were not.

May 21.

The Flowers ſhut up in uncompreſs'd Air were rotten, thoſe in the compreſs'd Air being unalter'd, except that the Mouldineſs was rather diminiſh'd.

May 30.

The Flowers being diſſolv'd and taken out, thoſe in the compreſs'd Air were ſubacid; From theſe Tryals it appears, that Compreſſion hinders Putrefaction.

EX-

EXPERIMENT III.

May 21. 77.

HALF an Orange being inclos'd in a Receiver, and as much in another; to which, ſo much Air was added, as rais'd the Mercury 100 Inches above it's uſual height. *Oranges ſhut up in a Receiver.*

May 25.

That in the uncompreſs'd Air was more mucid than the former.

May 26.

The compreſs'd Air getting out, it was ſupply'd by a new Addition.

May 30.

The Air being daily added as it got out, the Orange in the compreſs'd Air was more mucid than the other.

June 1.

The Oranges being taken out of the Receivers, that in the compreſs'd Air was much more corrupted than the other, ſo that, tho' Compreſſion hinders Corruption, yet 'tis promoted as the Quantity of Air is removed.

EXPERIMENT IV.

May 31. 77.

AN equal Quantity of Roſes being put into two Receivers, ſo much Air was preſs'd into one of them, as was able to raiſe the Mercury 90 Inches above the Height it is ſuſpended at, by uncompreſs'd Air. *Roſes ſhut up in a Receiver.*

June 11.

Thoſe in the uncompreſs'd Air had loſt a little of their Colour; but thoſe in the other Receiver had contracted a Yellowneſs, as if expos'd to dry in the open Air, neither were they mucid.

June 18.

Thoſe in the uncompreſs'd Air were very little alter'd, but thoſe in the compreſs'd Air, grew yellower and yellower: They were neither dry nor flaccid, nor was there any conſiderable Alteration in their Smell. But both being expos'd to open Air, thoſe were ſooner alter'd which were in the uncompreſs'd Receiver.

From whence it appears, that ſometimes compreſs'd Air is more diſpos'd to alter Colours, than uncompreſs'd; and it may not be amiſs to obſerve, that the Roſes after this manner ſhut up, did not acquire the leaſt Mucidneſs, but only a yellow Colour: But when the Experiment was try'd with Tulips and Lark-Spurs, the Succeſs was different. *See Exper.* II.

EXPERIMENT V.

June 1.

Oranges ſhut up in a Receiver.

I Put one half of an Orange in one Receiver, and the other half in another, adding to one, as much Air as was able to raiſe the Mercury, an hundred Inches above the Height it was ſuſtain'd at in the other.

June 6.

Both of them became mucid, but eſpecially that which was kept in the compreſs'd Air: In this Experiment it was to be noted, that the

the Air which was compreſs'd in the one Receiver, daily got out, and was as often renew'd.

June 11.

The Orange in the uncompreſs'd Air acquir'd no further Mucidneſs, tho the other did.

June 18.

The Mucidneſs of the Orange in the uncompreſs'd Air decreas'd; And tho' the other Orange ceas'd to encreaſe it's Mucidneſs, as long as it was not ſupply'd with freſh Air, yet ſo much freſh Air being ſhut up with it, as was able to raiſe the Mercury 80 Digits,

June 20.

It became much more mucid in two days time. Whence it appears, that as the Quantity of Air is more or leſs, ſo the Body enclos'd in it, is more or leſs mucid.

EXPERIMENT VI.

June 17. 77.

HAVING ſhut up two Shrew-Mice, and each of them in a diſtinct Receiver, we added ſo much Air to one of them, as rais'd the Mercury 30 Digits: But the Mouſe in the uncompreſs'd Air, was ſhut up, about 5 and 52', 6' after the other. *Shrew Mice ſhut up in a Receiver.*

The Mouſe in the compreſs'd Air ſeem'd to loſe its Strength a great deal ſooner than the other, the Motion of its Breaſt being not near ſo quick; nevertheleſs, about 6 and 18', that in the common Air dy'd Convulſive, yet that in the

compreſs'd Air, continu'd to be as well as it was an hour and half ago.

About 11 of the Clock that in the compreſs'd Air continu'd Reſpiration; but about 4 in the Morning it was found dead, in the ſame Poſture it was 7 hours before in; whence we may gueſs, that it was free from Convulſive Fits.

The Mouſe in the common Air had conſum'd, ſo much of it, that the Mercury in the Gage, which ſtood at 29 Inches, was rais'd to 30 when the Receiver was open'd.

From whence it appears, that compreſs'd Air contributes to the prolonging of Life.

EXPERIMENT VII.

June 13. 77.

Flies ſhut up in a Receiver.

I Enclos'd 4 Flies in a Receiver, with as much Air as rais'd the Mercury 60 Digits above it's uſual Height; 3 others at the ſame time being ſhut up with common Air.

July 14.

In the Morning they were all well. In the Afternoon 2 of thoſe in the compreſs'd Air were dead. About 5 all in the compreſs'd Air were dead but one, and the 3 in the common Air were alive.

July 15.

In the Morning, thoſe in the common Air were dead; but that in the compreſs'd Air being taken out, flew ſpeedily away.

From hence it appears, that they dy'd rather for want of Nouriſhment, than Air; ſince that which

which ſurviv'd in the compreſs'd Air, and had the Bodies of the other to feed upon, was not diſtemper'd.

EXPERIMENT VIII.

June 15.

EIGHT Flies being included in two diſtinct Receivers, and the Air in one compreſs'd more than in the foregoing Experiment. *Flies ſhut up in a Receiver.*

June 16.

Two in the common Air, and one in the compreſs'd were dead in the Morning. In the Afternoon all in the common Air ſeem'd dead.

June 17.

All, except one in the compreſs'd Air, were dead. From this and the foregoing Experiment it appears, that the Compreſſion or Rarefaction of the Air, affects Flies very little, except there be almoſt a compleat *Vacuum*.

EXPERIMENT IX.

June 18.

TWO Frogs being enclos'd in two Receivers, ſhut up by the help of Screws, the one with common Air, and the other with an Addition of as much as rais'd the Mercury 70 Digits. *Frogs enclos'd in a Receiver.*

June 19.

No Alteration was perceiv'd.

June 20.

The Frogs were alive, and the Air ſeem'd to be increas'd.

June 21.

In the Evening, that in the common Air was dead.

June 23.

In the Morning, that in the compreſs'd Air was dead.

Whether the Compreſſion of the Air, or Diſpoſition of the Body of the latter contributed to prolong it's Life, muſt be determin'd by further Obſervations.

EXPERIMENT X.

June 18. 77.

Oranges convey'd into a Receiver.

TWO halves of an Orange being ſhut up in two Receivers with Screws, ſo much Air was added to the one, as ſuſtain'd the Mercury 90 Digits.

June 22.

That in the common Air was mouldy: And at 3 a Clock Afternoon, the other had contracted a Mucor.

June 23.

That in the common Air was more mucid than the other.

June 24.

That in the compreſs'd Air was all over mouldy.

June 28.

That in the common Air had loſt it's Mouldineſs: The other was unalter'd.

Be-

June 30.

Being taken out, that in the common Air was half rotten; the other, wholly putrify'd, and mucid.

From hence it appears, that as the Quantity of Air is greater, ſo is the Body contain'd more mucid. The Mouldineſs in the compreſs'd, increas'd more intenſly, tho' it began not ſo ſoon.

EXPERIMENT XI.

June 29. 77.

TWO Receivers ſtopp'd with Screws containing Roſes, ſo much Air was ſqueez'd into one, as rais'd the Mercury 90 Digits. *Roſes enclos'd in a Receiver.*

July 14.

The Roſes in the common Air were alter'd. But the others began to wither and look yellow about 4 days ago.

July 17.

Being taken out, thoſe in the compreſs'd Air were much corrupted, and of an ungrateful Smell; The others had undergone very little Alteration. From hence it further appears, that the Quantity of Corruption depends on the Quantity of Air,

EX-

EXPERIMENT XII.

July 4.

A Limon being divided, and ſhut up in two Receivers with Screws, ſo much Air was added to one, as ſuſtain'd the Mercury 90 Digits.

July 7.

Both pieces ſeem'd to acquire a Mouldineſs at the ſame time.

July 17.

That in the compreſs'd Air, was much more hoary and putrid than the other. This Experiment does not only confirm what was inferred in the foregoing, but alſo that a Triple Compreſſion of the Air in Reſpect of a Limon, is too weak ſenſibly to retard the Production of Mouldineſs or Finew.

EXPERIMENT XIII.

July 18. 77.

Gilliflowers enclos'd in a Receiver.

ONE parcel of Gilliflowers being enclos'd in a Receiver with common Air, and an equal parcel in another, with as much compreſs'd Air, as ſuſtain'd the Mercury 100 Digits above it's wonted Preſſure.

July 23.

Thoſe in the compreſs'd Air were cover'd with a Mouldineſs: but the others were only moiſt: The Air was ſubſided 30 Inches.

The

July 25.

Thoſe in the compreſs'd Air were more compreſs'd than the others, and had loſt their Colour.

July 26.

Thoſe in the compreſs'd Air were wholly putrify'd, and cover'd with a hoary Finew; the others were only moiſt in ſome places.

Auguſt 1.

Thoſe in the compreſs'd Air being taken out, were rotten and ſtunk; the others were moiſt, retain'd their Colour, and ſmell'd not at all offenſive. This Experiment confirms, That the Quantity of Air doth increaſe Corruption; and alſo that Mouldineſs is not produced, but in compreſs'd Air.

EXPERIMENT XIV.

July 21. 77.

A Shrew Mouſe in common Air.

TO try whether a Shrew-Mouſe would conſume or produce Air, I ſhut it up in a Recipient with common Air. After 2 hours ſome was conſum'd; but the Mouſe died.

July 24.

Toward Evening, the Mercury ſeem'd a little higher.

July 25.

A great deal of Air was produc'd *de novo*.

July 26.

It increaſed conſiderably.

From whence it appears, that living Animals conſume, and dead ones produce Air.

EX-

EXPERIMENT XV.

Auguſt 31.

Pears enclos'd in a Receiver.

AS much Air was preſſed into a Receiver which contain'd Pears, as ſuſtain'd the Mercury 30 Digits above the uſual height.

Sept. 1.

The Mercury was depreſs'd.

Sept. 2.

It ſunk to 25 Inches.

Sept. 3.

It was rais'd to 26.

Sept 4.

It was 28 Digits high.

Sept. 8.

The Receiver being open'd, 5 of the Pears had loſt their Firmneſs, but 2 retain'd.

Auguſt 31.

The ſame ſort of Pears being ſhut up with common Air.

Sept. 1.

The Mercury was depreſs'd a little; I ſuppoſe by the Cold.

Sept. 2.

It was not changed.

Sept. 3.

It was rais'd a Digit.

Sept. 4	The height	4	*Sept.* 6	The height	$6\frac{1}{4}$
5	of it was	$6\frac{3}{4}$	7	of it was	12
			8		20

Be-

Being taken out, they retain'd their Taſte and Firmneſs, much better than in *Vacuo*.

Aug. 31.

The ſame ſort of Pears being ſhut up in *Vacuo*, ſo much External Air broke in, as ſuſtain'd the Mercury an Inch.

Sept. 1		4	*Sept.* 5		19
2	The Height	8	6	The Height	23
3	of it was	12	7	of it was	27
4		16	8		30

Being taken out, they had loſt their Taſte in a great meaſure, but reſerv'd their Firmneſs.

From theſe Experiments it appears, that as the Compreſſion is greater, the leſs Air is produc'd.

EXPERIMENT XVI.

Decemb. 7.

A Small Bird being ſhut up in a Receiver, which was large enough to contain 20 Ounces of Water, began to be ill, before I had ſet the Screw; but as much Air being preſs'd in, as rais'd the Mercury 30 Digits, ſhe ſeem'd to recover; but after a little time, ſhe began to be ill again: yet ſo much Air being thruſt in, as rais'd the Mercury to 45 Digits, ſhe recover'd a ſecond time; But ſome time after ſhe began to gaſp again; nevertheleſs, 28 Minutes after the Receiver was open'd, ſhe got out, and was very well. *A ſmall Bird.*

EX-

EXPERIMENT VII.

Jan. 20. 1678.

A Shrew-Mouſe in a Wind Gun.

A Shrew-Mouſe being ſhut up in my Wind-Gun, and the Air ſo far condens'd, that it reduc'd it to a twentieth Part of the Space it poſſeſs'd before, upon a Diſcharge of that Air, the Elliptick Hole being open'd, the Mouſe was taken out dead. Another Mouſe being put in, and the Air compreſs'd to a third Part of it's Space, it was taken out well. The Experiment was repeated, and the Air 7 or 8 times condens'd, by which the Mouſe ſeem'd not the leaſt prejudic'd; The ſame Experiment being repeated, the Air being 7 times compreſs'd, when the Mouſe had been ſhut up 24 Minutes, upon a Diſcharge of the Air, after repeated Groans, died. From whence it appears, that compreſs'd Air is noxious, yea, mortiferous.

EXPERIMENT XVIII.

Jan. 28. 78.

A Shrew-Mouſe in compreſs'd Air.

I Put a Shrew-Mouſe into a Glaſs, to whoſe Neck I ty'd a Bladder, ſtopping the Orifice, which being ſhut up in a Receiver, when the Mouſe began to be ſick, by preſſing new Air into the Receiver, the Bladder was ſtraitned, and tho' new Air could not penetrate into the Mouſe; yet the Air it was ſhut up in being compreſs'd, it was much better, and being taken out, in a ſhort time recover'd.

Ano-

Another Mouſe being ſhut up after the ſame manner, till it could ſcarce breath; when the Air was compreſs'd, its Reſpiration ſeem'd abated; upon which, the Receiver being open'd, and the Mouſe expos'd to the Air, it could not breath much more freely; yet when Air was blown upon it with a pair of Bellows, it ſeem'd reliev'd; but being again ſhut up with compreſs'd Air, it breath'd leſs frequently, and died.

March 25.

A Mouſe being ſhut up in an Inſtrument before deſcrib'd, when I perceiv'd the Mouſe ſick, I intruded Water into the Receiver, ſo that the Air was reduc'd into half the Space it poſſeſs'd before; upon which, the Mouſe breath'd more rarely; but the Air being ſucceſſively compreſs'd and left to it's liberty again, the ſick Mouſe ſeem'd to breath more lively in the common Air, than in the compreſs'd. Whence I conjectur'd, that the Air is to Animals as Food, which ought to bear ſome proportion to the Strength of the Animal. In Confirmation of which Conjecture, I ſhut up a Mouſe in my Pneumatick Engin, and rarifi'd the Air ſo much, that it poſſeſs'd three times the Space it did before; upon which, the Mouſe ſeem'd better, but preſently began to be ſick, yet underwent no ſenſible Alteration upon an intromiſſion of Air: The like ſucceſs happen'd three times ſucceſſively, tho' at the laſt the Mouſe died.

A R-

ARTICLE V.

The Effects of Artificial Air *upon Animals.*

EXPERIMENT I.

May 5. 77.

A Bee in Artificial Air.

A Bee, together with diſtill'd Vinegar, and Powder of Coral, being convey'd into a Receiver; I ſo contriv'd the matter, that when the Receiver was exhauſted, the Coral fell into the Vinegar: But the Air produc'd, had no Effect on the Bee; yet when it had been a little expos'd to the Air, it began to move: Whence we may gather, that Artificial Air is not fit for Animals to live in.

EXPERIMENT II.

Auguſt 12. 76.

Flies in Artificial Air.

TWO Flies being contain'd in a Receiver, with as much Artificial Air of Goosberries as ſuſtain'd 26 Inches of Mercury: And two others being ſhut up in *Vacuo*, adding common Air enough to ſuſtain 23 Digits of Mercury, upon which, in a quarter of an hour the latter began to fly, but thoſe in the Artificial Air lay without motion.

Thoſe

Aug. 13.

Thoſe in the Artificial Air ſeem'd dead; the others were well; nor did the former recover, tho' expos'd to common Air a whole day.

Aug. 18.

The ſame Experiment was repeated with the like Succeſs. This Experiment is a further Confirmation, that Artificial Air is noxious to Reſpiration.

EXPERIMENT III.

June 22. 77.

PASTE being contain'd in 3 exhauſted Receivers. *Paſte included in 3 Receivers.*

June 23.

Into one I put a perfum'd Cone kindled, which was extinguiſh'd in a Minute, as ſoon as the Receiver was ſtopp'd; yet in common Air, it burnt bright for ſome time after the Receiver was ſtopp'd.

Another Experiment being try'd with a Fly, I obſerv'd, that tho' when it was ſhut up in Artificial Air for ſome time, it ſeem'd dead, till reviv'd in the Sun-Beams; yet another ſhut up in common Air, receiv'd no damage: The like Succeſs follow'd, when we try'd the Experiment a ſecond time, ſave that the Bee being taken out of the Artificial Air, was ſomething longer before ſhe recover'd. From hence it appears, that Artificial Air is prejudicial to Fire as well as to the Life of Animals.

EXPERIMENT IV.

Jun. 25. 77.

HAving enclos'd Paſte in four Receivers, two of which were exhauſted, and the other two but half evacuated.

June 26.

Thoſe which were half full of common Air, being fill'd with Artificial, I put two Flies into one of them, which were depriv'd of Motion, as ſoon as they came to the Bottom; A Third, and then a fourth, ſucceſſively being put in, they continu'd to live longer; yet after ſome Convulſions, lay unmov'd and ſupine; But being remov'd into common Air, in a little time they came to themſelves: Thoſe Flies that were put into Receivers, which only contain'd common Air, were well ſooner.

June 27.

One of the Receivers which had been wholly exhauſted of common Air, being caſually thrown down, gave way to an Ingreſs of external Air; A Frog being being put in, was not much diſaffected.

June 30.

The fourth Receiver being forced away from it's Cover, I put a Frog into it, which after five minutes high Convulſions, lay without Motion four minutes; and then being taken out of the Receiver, continu'd ſo 46 minutes; but in five minutes more grew very well.

From hence it appears, that if Artificial Air be mix'd with common Air, it is ſo much the leſs prejudicial to Animals.

EX-

EXPERIMENT V.

June 28.

I Enclos'd Paſte in four Receivers, 3 of which were wholly exhauſted of common Air, but the fourth was left half full. *A Frog in Artificial Air.*

June 29.

One of the Receivers being full of Artificial Air, and a Frog put into it, after it had been violently Convulſive for 4 or 5 Minutes, and lay void of Motion for about a Minute, being taken out of the Receiver, in about 5 Minutes, began to move, and was well again in a little time.

A Frog being put into another Receiver with Artificial Air, was Convulſive for about 7 Minutes, and then lay void of Motion for about a Minute; yet when it was taken out of the Receiver, it began to ſtruggle and move, after which Motions, which ſeem'd to be the Relicks of its Convulſions, it lay for about half an hour void of Motion again; yet, at the laſt, it recover'd a ſecond time.

A Frog being caſt into that Receiver, which was but half exhauſted, for ten Minutes ſeem'd Convulſive; and then, lying ſtill for about a Minute, the Receiver being open'd, within half an hour recover'd power to move again: But in the Experiment it was to be noted, that the Quantity of Artificial Air, was ſo much encreas'd before the Frog was caſt in, that part of it, and conſequently ſome of the common Air made it's way out.

A Frog being ſhut up in a Receiver with common Air.

July 1.

In the Morning it was alive, in the Afternoon dead; It liv'd near 48 hours.

June 30.

A Frog being ſhut up with Artificial Air wholly, after 7 Minutes Convulſions died; nor did it recover, tho' taken out 2 Minutes after.

July 1.

It did not recover: Hence it appears further, that Artificial Air is moſt detrimental, when leaſt common Air is mix'd with it.

EXPERIMENT VI.

June 30.

Paſte included in a Receiver.

PASTE being ſhut up in two exhauſted Receivers.

July 4.

Some little Air having got into one Receiver, I put a Shrew-Mouſe into it, who after vehement Convulſions, died in a Minute.

A Snail being put into the other Receiver, continu'd to move vehemently for a quarter of an hour, after which time, its Motion gradually declining, in a quarter of an hour it ſeem'd dead, but in a ſhort time grew well again.

Flies being ſhut up in another Receiver, were not at all prejudic'd, too much External Air having got in.

From hence it appears, That Artificial Air is prejudicial, upon the Account of ſome venomous

mous Quality; and not only by defect of Common Air; ſince Snails liv'd a longer time *in Vacuo.* See *Art.* VI. *Exp.* III.

EXPERIMENT VII.

July 5. 77.

A Frog in Artificial and Common Air.

HAving tranſmitted Artificial Air of Cherries out of One Receiver into another, full of Common Air, in which a Frog was contain'd; ſo much Water flow'd out, as was ſufficient to give way to the Ingreſs of the Artificial Air. Upon which the Frog being Convulſive for about a Quarter of an hour, lay ſtill; yet ſoon recover'd again, when expos'd to the Air.

This Experiment ſeems to prove, that Artificial Air of Cherries is leſs pernicious than that of Paſte; *See Exp.* V.

EXPERIMENT VIII.

July 9. 77.

Goosberries enclos'd in Vacuo.

GOosberries were ſhut up in three empty Receivers.

July 20.

So much Air was produc'd, as ſeparated the Cover from the Receiver: Two Flies being caſt ſucceſſively in, preſently Died; a third ſeem'd Convulſive; a fourth in leſs than a quarter of a Minute lay without Motion: The Receiver being clear'd of the Artificial Air it, grew well.

July 24.

A Shrew-Mouſe being ſhut with Air from Goosberries, Died in half a Minute.

Hence it may be inferr'd, that Air produc'd from Fruit is leſs prejudicial than Air obtain'd from Minerals; for *July* 20 a Mouſe being ſhut up with Air produc'd from Gunpowder, Died in a Quarter of a Minute.

EXPERIMENT IX.

July 5. 77.

Paſte in Vacuo. PAſte being contain'd in four exhauſted Receivers.

July 6.

One was forc'd from it's Cover: Some Common Air got in before it could be ſtopped. A Shrew-Mouſe being put in, was Convulſive a Minute and ½ and then remain'd moveleſs: Being taken out, after ſome Convulſive Motions, Died.

July 7.

A Bird ſhut up as the Mouſe was, in a quarter of a Minute Died: A Bird of the ſame kind being ſhut 4 Minutes with common Air, was very well.

July 9.

The ſame Bird which continu'd well in the Common Air, Died when enclos'd with Artificial Air, in a quarter of a Minute.

An Adder being ſhut up with Artificial Air, in 2 Minutes began to be ill; and in 24 Minutes was depriv'd of Motion, and tho' 6 Minutes after it was expos'd to the Air, yet it recover'd not.

July 10.

There was no hopes of Recovery.

EXPE-

EXPERIMENT X.

July 12. 78.

A Bird ſhut up with Air from Raiſins Died in ¼ of a Minute. *A Bird in Artificial Air.*

July 18.

A Shrew-Mouſe being ſhut up with the ſame ſort of Air, after 2 Minutes ſeem'd ill and void of Motion; yet in 2 or 3 Minutes was well again.

EXPERIMENT XI.

Octob. 1. 78.

A A Shrew-Mouſe being ſhut up an hour in Common Air could ſcarce Breath. Another being caſt into the ſame Receiver, before the Stopple was clapt on again, ſome freſh Air broke in, by which the firſt Mouſe was refreſh'd; yet about an hour after both died. About 4 after Noon, another Mouſe being clap'd in very cautiouſly, died in 3 Minutes. Whence it appears, that the ſame Air is not long fit for Reſpiration. *A Shrew-Mouſe in a Receiver.*

EXPERIMENT XII.

April 28.

A Snail being enclos'd with Air from Paſte, froath'd, and contracted and expanded ſucceſſively, till in 4 Minutes it became void of Motion; At a quarter of an hours end, being taken out, it was void of Motion: Yet being *A Snail in Artificial Air.*

prick'd with a Pin, a quarter of an hour after mov'd a little.

A Snail being ſhut up when that Air was blown out, was not ill at all: whence it appears, that Artificial Air is more prejudicial to Animals, than a *Vacuum*.

EXPERIMENT XIII.

Jun. 22. 78.

Green Peaſe in a Receiver. IN a Dayes time green Peaſe yielded Air enough to ſuſtain 10 Digits of Mercury.

Jun. 23.

The Mercury was 30 Digits high.

Jun. 24.

It roſe no higher. The Cover and the Receiver ſtuck not together, yet no Air got out.

Jun. 26.

The ſame Peaſe being ſhut up in the ſame Empty Receiver.

Jun. 29.

A Snail being thrown in, and the Receiver being full of Factitious Air, it froth'd, and frequently contracted and expanded; but after ſix Minutes, lay ſtill 2 or 3. Being taken out it mov'd a little.

Whence we gather, that Factitious Air of Peaſe is not ſo prejudicial to Snails as that of Paſte. *See Experiment* XII, XI. The Factitious Air being blown out, a Snail did very well in the Receiver. In this Experiment it is obſervable, that Peaſe ſooner yeild Air *in Vacuo*, than in Compreſs'd Air.

ARTI-

ARTICLE VI.

Animals in Vacuo.

EXPERIMENT I.

Jun. 22. 76.

A Butterflie mov'd 3 hours *in Vacuo*, and recover'd it's Motion when loſt, upon an ingreſs of Air. Being hung by a thred, tied to one of her horns, it was mov'd from one ſide of the Receiver to the other by the Motion of it's Wing, but when the Air was drawn out, we could not move the Thred from a perpendicular Poſture. *A Butter-Fly* in Vacuo.

EXPERIMENT II.

July 12. 76.

TWo Flies being ſhut up with as much Air as ſuſtain'd 10 Inches of Mercury, the biggeſt ſeem'd preſently Dead, tho' the other liv'd 24 hours. When both Flies lay as Dead, ſo much Air was let in as rais'd the Mercury to 15 Inches; upon which the leſs Flie began to move. Inſects may breath in rarifi'd Air ſooner than in Artificial. *Two Flies* in Vacuo.

EX-

EXPERIMENT III.

May 1.

Two Snails in Vacuo.

TWo Snails ſeem'd well for the ſpace of an hour *in Vacuo* and crept up to the Top of the Receiver; but in two hours fell down void of Motion: 4 hours after, being expos'd to the open Air they began to move. Whilſt they were ſhut up they help'd to produce Air enough to raiſe the Mercury $\frac{1}{4}$ of an Inch.

They liv'd longer *in Vacuo*, than others in Artificial, *Art.* V. *Exp.* VI.

EXPERIMENT IV.

Auguſt 12. 76.

Fly-Blowings in a Receiver.

FLy-blowings were put into an empty Receiver.

Auguſt 14.

Worms were form'd: So much Air got in as was ſufficient to ſuſtain Mercury 15 Digits.

Whence it is evident, Inſects may be produc'd and live in very rarifi'd Air. *See Exp.* VI. and VIII.

EXPERIMENT V.

March 17. 77.

Frog-Spawn.

FRog-Spawn being divided into two equal Parts, and each of thoſe included in a diſtinct Receiver, the Spawn being firſt put into glaſs Veſſels; one of the Receivers was expos'd

expos'd to the Sun, being totally exhauſted; the other was left full of Air.

That *in Vacuo* ſwell'd into Bubbles.

May 2.

The Bubbles remain'd *in Vacuo*. No Frogs were produc'd in either. 3 Days ſince the Bubbles diſapear'd; and the Spawn turn'd into a green Liquor.

July 2.

The Spawn *in Vacuo*, and the Water contain'd in the Veſſel being rais'd in Vapours, ſtuck to the ſides of the Receiver, and there condens'd: The Spawn and Water in the Common Air retain'd their own Form.

EXPERIMENT VI.

Auguſt 16. 77.

Flies Eggs.

I Enclos'd Flies Eggs in an empty Receiver.

Auguſt 29.

No Worms being produc'd, I let the Air into the Receiver.

Sept. 4.

They produc'd nothing: This Experiment compar'd with the IV, ſeems to ſhew, that tho' Inſects may be produc'd and live in Air highly rarifi'd, yet they cannot *in Vacuo*.

EXPE-

EXPERIMENT VII.

June 15.

A Frog in Vacuo. A Frog enclos'd 14 hours in an exhauſted Receiver, Died.

June 16.

The Experiment being repeated; in 2 hours the dead Frog afforded ſome Air.

June 18.

The Frog *in Vacuo* was ſwell'd; but the Air being let in, it was more lank than before.

Artificial Air is more prejudicial than a *Vacuum* to the Life of ſuch Animals. See *Exp.* IV, and VII, of *Art.* V.

EXPERIMENT VIII.

Auguſt 3. 78.

FLie-Blowings ſticking to Fleſh being ſhut up *in Vacuo.*

Auguſt 12.

No Worms generated.

Auguſt 15.

There being no Alteration in the Eggs; Air was let into the Receiver.

Sept. 15.

They produc'd nothing. This is a confirmation of the Inference drawn from *Exp.* IV.

EXPE-

EXPERIMENT IX.

April 22. 78.

VInegar full of ſmall Eels, or Vinegar Worms was ſhut up *in Vacuo*. *Vinegar with Eels in Vacuo.*

Auguſt 29.

The Worms ſtill mov'd, the Number being fewer than before.

Sept. 6.

Yeſterday they mov'd: To day they were all dead. Thoſe left in the open Air were as lively as before. Whence it is evident, that the Air influences even thoſe diminutive Animals.

ARTICLE VII.

Fire in Compreſs'd Air.

EXPERIMENT I.

May 14.

I Enclos'd ſuch a Cone in a Receiver, as is uſually wholly conſum'd in the open Air before extinguiſh'd, and then intruding as much Air as rais'd the Mercury 120 Digits high above it's uſual height, I kindl'd the Cone with a burning Glaſs; when ½ parts of an Inch were conſum'd and the Receiver fill'd with Smoak, I took *Perfum'd Cones* in Vacuo.

took it out, and found that the outſide was only burnt, the inner Parts being left untouch'd.

Another Cone being ſhut up with uncompreſs'd Air, in a Receiver ſomething larger, much leſs of it was conſum'd, than of the former.

EXPERIMENT II.

May 11.

A Perfum'd Cone being enclos'd in a Receiver, and kind'ld in uncompreſs'd Air, being weigh'd when the Fumes were condens'd, it had loſt a Grain.

Another being ſhut up with as much Air as elevated the Mercury 90 Inches, loſt 4 Grains more than the former. So that the more Air is contain'd in the Receiver the greater is the Conſumption of the Matter burning in it.

EXPERIMENT III.

May 17. 77.

A Perfum'd Cone being ſhut up with a Screw in a Receiver, with as much Air as ſuſtain'd 60 Inches of Mercury above it's uſual height, being ſet on Fire with a Burning-Glaſs, it loſt 3 Grains and a half. The Experiment being repeated in Air compreſs'd ſo much as to ſuſtain 120 Inches, loſt 7¾ Grains.

May

May 17.

The Experiment being try'd, when the Mercury was at 97 Inches, it loſt 6 Grains. This Experiment confirms the Inference drawn from the foregoing, and ſhews that the Conſumption bears a greater Proportion to the Compreſſion, than the Compreſſion to the Conſumption.

May 18. 77.

A perfum'd Cone being ſhut up in a Receiver, 7 times as big as before, loſt $3\frac{1}{4}$ of it's Weight; which Air, had it been compreſs'd into a 5*th* part of that Space, the Cone would have loſt 10 Grains.

Whence it appears, that the Condenſation of the Air promotes the Conſumption of the Matter contain'd in it.

EXPERIMENT IV.

May 19. 77.

THE ſame Experiment being repeated in a Receiver cloſely ſtopp'd with a Screw, the Cone loſt a Grain and a quarter.

May 21.

The ſame Experiment being repeated, and the Cone ſet on fire, it loſt 4 Grains.

May 23.

It was twice repeated, but the Cone not being well fir'd; In one it loſt $\frac{1}{4}$ of a Grain; in the other, a whole one.

May 24.

The Cone loſt 1 Grain and $\frac{1}{4}$: The Cone being taken out, and cleanſed of the Soot, it loſt in

in a Receiver, 6 Grains ½. In an uncleanſed Receiver it loſt 3 Grains in Weight.

May 25.

In a cleanſed Receiver it loſt 6 Grains ½. In one well cleanſed after it loſt 7 Grains ½. In a Receiver unwaſh'd, the Cone would ſcarce be kindled.

May 26.

In a Receiver unwaſh'd, in the middle of a Sun-ſhine Day, the Burning-Glaſs being long apply'd, it was 8 Grains lighter.

Whence it appears, that tho' the Conſumption of the Matter be not always the ſame in the Quantity of Air, yet it is greater, according to the Degrees of Compreſſion.

EXPERIMENT V.

May 22.

HAving enclos'd a perfum'd Cone with ſo much Air as rais'd the Mercury 30 Digits above it's uſual height; it loſt 1¾ of a Grain.

May 23.

The ſame Experiment was try'd with the ſame Succeſs. The ſame Experiment being try'd again, the Receiver broke into 100 pieces. *See Exper.* 3. yea in *Exp.* VI. of *Art.* II. tho' it reſiſted Air compreſs'd enough to ſuſtain 198 Digits, yet another time it was broke with a ſixth part of that Preſſure: Therefore a Man ought, in trying ſuch Experiments, to guard his Head, leſt a Receiver accidentally breaking, ſhould fly in pieces and wound him.

A R-

ARTICLE VIII.

Fire us'd to produce Air.

EXPERIMENT I.

June 4. 76.

PAper beſmear'd with Sulphur, and burnt in *Vacuo*, yielded Air, which laſted 2 Days without Diminution. *Paper beſmear'd with Sulphur.*

EXPERIMENT II.

June 15.

HArts-Horn burnt in *Vacuo*, yielded ſome Air. *Harts-horn in* Vacuo.

June 17.

Air produced by burnt Harts-horn was ſoon deſtroy'd; but if it laſted an hour undiminiſh'd, it uſually continu'd a conſiderable time.

June 19.

Harts-horn taken out of the Receiver yielded a fetid Oyl, but no Volatile Spirit.

EXPERIMENT III.

June 21.

AMber being burnt in a Receiver, aſcended in Fumes up to the Top, and thence reflected downwards; but burnt in *Vacuo*, they *Amber in* Vacuo.

roſe not above a Digit at the firſt; but afterwards it roſe almoſt to the Top: The Mercury in the Gage was not alter'd in it's height.

June 22.

Water, in which the Receiver was immers'd, got into the Receiver.

July 8.

No more Water got in: Nor did the Amber produce the leaſt Air.

EXPERIMENT IV.

Jan. 18. 77

Camphire included in a Receiver.

TWO Drachms of Camphire being put in an empty Receiver upon a Digeſting Furnace.

Jan. 19.

It was ſublimed into Flowers; no Air was produced.

EXPERIMENT V.

May 24. 76.

Sulphur Viv. melted in a Receiver.

SULPHUR *Viv.* being melted in an exhauſted Receiver by the help of a Burning-glaſs, yielded no Air.

EXPERIMENT VI.

July 19.

PASTE included in a Receiver and burnt, afforded ſo much Air, that the Cover which be-

before could not be mov'd without difficulty, eaſily parted from the Receiver.

ARTICLE IX.

Concerning the Production of Air *in* Vacuo.

EXPERIMENT I.

Sept. 9. 76.

AN Exhauſted Receiver being half full of dry'd Grapes. *Dry'd Grapes in Vacuo.*

Sept. 10		$\frac{1}{12}$		*Sept.* 22	The Aſcent	$\frac{1}{8}$
12	It aſ-	$\frac{1}{12}$		27	was	$\frac{1}{8}$
14	cended	$\frac{2}{12}$			The Height was	
17		$\frac{3}{12}$			3 Digits.	

Octob. 11.

The Mercury was 6 Digits high.

Sept. 9. 76.

A Receiver being half full of dry'd Figs, the Air was drawn out till it ſtood at 3 Inches.

Sept. 10.

No Air produced.

Sept. 17.

No Air. Whence it appears, that there is no Regularity in the Production of Air from dry'd Fruits.

EXPERIMENT II.

August 5. 76.

Pears and Apricocks.

PEARS and Apricocks were ſhut up in *Vacuo.*

Aug. 6.

In 18 Hours the Mercury was rais'd 2 Inches; In ten Hours more the Height of it was 3 Digits.

Aug.	7	The height was	5	*Aug.* 9		In 14 hours it was 7¼ Inc. hig.	
	8		6½				

Aug.	10	The height was	8¾	*Aug.*	20	The height was	31⅓
	11		10¾		21		32⅓
	12		12¼		22		34
	13		14¼		23		35
	14		16		26		38½
	15		18		29		41
	16		20	*Sept.*	1		42½
	18		25		4		44
	19		29				

Sept. 7.

The three laſt Days being hot, it was rais'd to 46½.

Sept.	10	The height was	47⅓	*Sept.*	27	It was	50⅓
	13		44	*Nov.*	5		52½
	23		48				

Nov. 28.

The Apricocks were reduc'd to Water; the Skin being ſever'd from the Pulp, no more Air was produc'd.

It

Jan. 10. 77.

It was a hard Froſt, at which time the Mercury came to 57 Inches. Upon a Thaw, it was depreſs'd to 23.

March 3.

The Apricocks were putrifi'd and had loſt their Colour. Hence it is evident, that Apricocks afford Air almoſt as faſt in their wonted Preſſure as in *Vacuo*.

EXPERIMENT III.

June 20. 76.

SOwre Cherries whole, being put into one Receiver, and others cut into another; The whole ones rais'd the Mercury in two hours, 10 Lines; the diſſected ones, 20. *Sowre Cherries.*

June 21.

The whole ones rais'd the Mercury to 3 Inches; the other Gage was ſpoil'd.

June 26.

The whole ones rais'd the Mercury 15 Digits; The other Receiver was full of Air.

July 9.

The Receiver being remov'd from it's Cover, I eat a Cherry, which was well taſted: The reſt being included in *Vacuo*, and ſome of them broke, in an hour rais'd the Mercury 2 Digit.

July 10.

The Mercury aſcended not, becauſe the Gage was ſpoil'd.

July 15.

The Cover was ſever'd from it's Receiver. Whence it appears, that diſſected Fruits produce Air ſooner than whole ones.

EXPERIMENT IV.

June 9. 77.

Cherries in Vacuo. CHerries being put into a Receiver, rais'd ¼ of a Digit of Mercury, in an hour.

Jun. 10.

The Mercury was rais'd in 18 hours to the height of 11 Digits.

June 11	It roſe to	15	*June* 16	It roſe to	30
12		15+	18	the Receiver	
13		22		was open'd.	

Fruits of the ſame kind in *France* fill'd their Receiver in 2 Days; and probably there may be the like difference in other Fruits, in ſeveral Countries.

EXPERIMENT V.

June 12. 76.

Cabbages in Vacuo CAbbages being included in a Receiver, in an hours time rais'd the Mercury a Line.

June 13.

It was rais'd to 10 Digits.

June 17.

It was rais'd almoſt to the Top of the Gage; the Cabbages being very little alter'd.

Ha-

June 19.

Having been 2 days expos'd to the Air, were corrupted and blackiſh; being ſhut up in *Vacuo*, they rais'd the Mercury ½ an Inch.

June 22.

It was rais'd to the height of 1½.

June 23.

No more Air being produc'd, the Cabbage was taken out: It ſtunk much: So that I ſuſpected, that Bodies have afforded as much Air as they can before they putrifie.

EXPERIMENT VI.

May 29. 76.

HAving ſhut up two pieces of Orange, which weigh'd 4 Ounces, in 2 exhauſted Receivers, large enough to hold 10 Ounces of Water. *Oranges in Vacuo.*

June 10.

They remov'd the Receiver from it's Cover; upon which, I ſhut them up in an exhauſted Receiver, capable of containing 8 Ounces of Water; upon which the Mercury aſcended ½ of a Digit.

June 13.

It was almoſt 2 Digits high.

June 16.

It aſcended about 3 Lines.

June 21

It aſcended not one Line.

July 18.

Th' Mercury was no higher, but ſome Mouldineſs appear'd.

EXPERIMENT VII.

April 27. 76

A Tulip in Vacuo.

A Tulip being ſhut up in a Receiver, with as much Air as rais'd the Mercury 2 Digits.

May 2.

That which before was ſtrip'd, put on a dark Red, and became moiſt: It afforded but little Air.

EXPERIMENT VIII.

April 22. 76.

A Limon in Vacuo

A Limon ſhut up with a Mercurial Gage 3 Digits long.

April 24	It was	1¼	Digits	*Apr.* 27	It	1 Line
25		2	high.	28	roſe	1 Line
26	It was 4 Lines higher.			29		

May 3.

In four Days it aſcended a little above a Line.

May 3. 77.

The Limon was a little alter'd; The Mercury was rais'd to the Top of the Gage.

Jan. 1. 17.

The Limon had contracted a Yellowneſs and Moiſture.

EX-

EXPERIMENT IX.

March 16. 67.

AN Apple which began to putrifie, was put into one Receiver, and a bruis'd one into another. *An Apple in Vacuo.*

May 15.

The bruis'd Apple appear'd wholly rotten; and the Receiver was forced from it's Cover. The other Apple was unalter'd.

Aug. 20.

That which before began to putrifie, was yet unalter'd; It taſted grateful, but ſubacid; The Pulp was of a mealy Conſiſtence.

This Confirms the Inference from the 5*th Exp.* of this Article.

EXPERIMENT VII.

May 17. 76.

AN equal Quantity of Milk being ſhut up in common Air, and in *Vacuo*. *Milk in Vacuo.*

May 18.

That in the common Air was cover'd with Cream; the other, with Bubbles.

May 19.

The Bubbles ſwell'd more and more, the Mercury was rais'd a little.

May 20

The Bubbles ſwell'd more and more, and the Milk ſeem'd curdled: The Mercury in the Gage being

being rais'd to the Top. The Milk in the free Air was evidently curdled.

May 22.

The Milk in *Vacuo* being curdled, yielded more Air yet, almoſt all the Bubbles being broke: From this Experiment it appears, that Milk is ſooner coagulated in open Air than in *Vacuo*.

June 20.

The Milk in the free Air ſtunk, and was full of Worms; and emitted ſeveral large Bubbles when the Air was drawn out; the Worms mov'd vehemently, and all liv'd four hours. All the Bubbles on the Milk in *Vacuo*, were broke, and it continu'd coagulated.

May 19. 77.

Some Whey in *Vacuo*, was pour'd out of a Veſſel into a Receiver about 4 days ago, it ſeemed limpid like Water: The Whey remaining in the Veſſel, was ſufficient to ſeparate the Butyrous from the Caſeous Part.

To day the Milk ſtagnant in the Receiver, ſeem'd to be got out; the Cover being forced from the Receiver. Towards night, the Milk being taken out of the Receiver, was found acid, both in Smell and Taſte: After a little time, the limpid Whey diſappear'd, being mixt with the Caſeous and Butyrous Part.

May 24.

The Butyrous Part vaniſh'd, and the Milk began to ſmell amiſs.

June 1.

The Milk had no very bad Smell, nor had it produc'd Worms, but grew dry, and then the Mice eat it up.

In

In this Experiment the following Particulars were remarkable. *Firſt*, That the Coagulation was ſlower when the Air was drawn out. *Secondly*, The Weight of Butter, Whey or Cheeſe, is not the ſame in the Air, as in *Vacuo*, becauſe one ſwims on the Top of the other. *Thirdly*, The Putrifaction of Milk is retarded, by drawing out the Air. *Fourthly*, Milk by being kept in *Vacuo*, is not unfit to generate Worms, when expos'd to common Air.

EXPERIMENT XI.

Sept. 5. 77.

HAving enclos'd 3 Ounces and 3 Drachms of Urine in a Receiver, capable of holding 10 Ounces. *Urine in Vacuo.*

Sept. 7.

The Mercury was rais'd 2 Digits.

Sept 8.

It was ſomewhat higher.

Decemb. 5.

The Mercury aſcended to the height of 3 Inches. The Urine was unalter'd.

Decemb. 6.

Urine was ſet under a Receiver, being left open to the common Air.

Decemb. 16.

The Urine in *Vacuo* was not chang'd. The other in 10 days time ſeem'd Turbid, and it's Superficies mouldy.

From this and the foregoing Experiment we may infer, that Urine contains leſs Air than Milk.

Beſides

Beſides, the Efficacy of Air corrupting Urine is worth Notice.

EXPERIMENT XII.

May. 19.

Diluted Paſte. A Veſſel half full of diluted Paſte, which was without Leaven, being convey'd into a Receiver, before the Receiver was quite exhauſted, the Paſte was ſwollen quite to the Top of the Veſſel.

May 20.

It ſwell'd more, ſeveral Cavities being interſpers'd through it.

May 22.

It yielded more Air, and was much more tumid.

May 23.

The Receiver was ſeparated from the Cover by the Air produc'd in the Receiver. The ſwelling of the Paſte was ſomething abated, and it was much more ſo in the Afternoon: It did not Taſte Acid.

EXPERIMENT XIII.

July 20. 76.

Beef in Vacuo. A Quantity of Beef being put into one exhauſted Receiver; and a like Quantity into another, which was in ſome Meaſure expos'd to the Air.

The

July 21.

The exhauſted Receiver was fill'd with Air: But ſuſpecting that ſome Air had got in, I ſhut the Beef up in another Receiver.

July 22.

The Mercury in 14 hours was rais'd 15 Inches.

July 25.

The Receiver was not half full of Air.

July 26.

The Receiver was ſever'd from it's Cover; and the Beef being again included *in Vacuo*, ſuſtain'd 10 Digits of Mercury in an hours time.

July 28.

The Receiver was full, and when re-exhauſted, the Beef yielded a great deal of Air again in a ſhort time.

July 30.

The Receiver was again fill'd, and being exhauſt'd, the Beef yielded ſo much Air in an hour as was able to ſuſtain 10 Digits of Mercury.

Auguſt 1.

The Receiver being again full, and the Beef Stinking, we threw it away. Hence it appears, that,

Fleſh yields more Air whilſt it Putrifies than before, but it is otherwiſe with Fruits. See *Exp.* IX of this *Article.*

EXPE-

EXPERIMENT XIV.

July 18. 78.

Goosberries in Vacuo. GOosberries being ſhut up in *Vacuo*; In half an hour the Mercury was rais'd a Digit: In an hour and half it was rais'd another.

July 19.

The Receiver was almoſt fill'd.

July 20.

The Receiver and it's Cover being parted, a good deal of Juice ran out.

July 29.

The Goosberries wereagain included in *Vacuo.*

July 30.

In 16 hours the Mercury rais'd an Inch and ½.

July 30. 77.

They did not wholly fill the Receiver: Some time ſince they loſt their red Colour, and inclin'd to a White one.

It ſeems from hence to follow, that ſince after they had yielded all their Air, they underwent no change, that Air was the Cauſe of Corruption.

EXPERIMENT XV.

Aug. 23.

Pears in Vacuo. PEars being included in a Receiver, with as much Air as rais'd the Mercury an Inch and

and $\frac{1}{2}$. In two hours it was almoſt 6 Inches high.

Aug. 24		12		*Sept.* 1		32		
25		16		2		35		
26	It	18		3	It	$38\frac{1}{3}$		Inches
27	was	21		4	was	44		high.
28		23		5		45		
31		30		6		50		

Sept. 7 The height was the ſame; ſome Air getting out.

Sept. 9		$53\frac{1}{3}$			
8	It was	$54\frac{1}{2}$			Inches high.
10		58			

Sept. 12.

Yeſterday there was no Alteration: To day, as I ſuſpected, ſome Air getting out, it was $53\frac{1}{3}$.

Sept. 13.

Being tranſmited into another Receiver it was $32\frac{1}{2}$.

Sept. 16.

The Receiver being open'd the Pears were Rotten.

EXPERIMENT XVI.

From *Sept.* 17 to 22.

PLums dried being enclos'd in a Receiver yielded very little Air. *Plums* in Vacuo.

Nov.

Nov. 8.

The Receiver was open'd, no more Air being produced.

EXPERIMENT XVII.

Sept. 28.

Nut-Kernels.

Nut-kernels being enclos'd in a Receiver.

Sept. 26	It	A little	*Oct.* 15	It	10	Digits
30	roſe	2 Inches	22	was	15	high.
Octob. 6	By degrees to 6 Inches.						

Nov. 28.

It was 20 Digits high. The Kernels had neither loſt their Colour nor Taſte: So that Air may be procur'd from Fruit of an hard Conſiſtence, without Putrefaction.

ARTICLE X.

Concerning the Production of Air *above it's wonted Preſſure.*

EXPERIMENT I.

Jun. 22.

Peaſe with a Glaſs full of Raiſins.

New Peaſe were ſhut up in a Receiver with a Glaſs full of Raiſins of the Sun bruis'd and mixt with Water. To-

Towards Evening the Raiſins yielded Air enough to raiſe the Mercury 12 Digits.

Jun. 23		49		The Peaſe turn'd Yellow and ſeem'd to Sweat.				
24	It	75	Digits	*Jun.*	30			110
25	was	90	high.	*July*	1		It	110
26		90			4		was	124
28		100			7			140

July 16.

It remain'd at the ſame height; but the Liquor which came from the Peaſe got out.

July 12.

New Liquor was produc'd; The Mercury neither roſe nor fell.

July 13.

The Liquor got out, and ſome Air; But the Cover being better adapted, new Liquor was produc'd.

July. 25.

The Receiver was broke in Pieces. The Peaſe kept their Taſte, and parted from their Husks as if they had begun to boyl.

EXPERIMENT II.

Sept. 15. 76.

Uripe Plums in Compreſſ'd Air.

UUripe Plums being ſhut up with as much Air as ſuſtain'd an Inch of Mercury.

Sept.	16		6	*Sept.*	22		18
	17		8		23		18
	18	It roſe to	10		24	It roſe to	19
	19		12		26		23
	20		14		28		26

Octob.	1	It	30	*Octob.*	17		38
	4	was	31		19		39½
		It was ſome-what Cold.			22		41
					26	It roſe	43
	5		32		29	to	45
	7	It	33	*Nov.*	2		46
	9	roſe	33½		5		47
	11	to			20		53
	14		27				
	15		The Cold abated.				

The Production of Air is, in this Experiment, ſometimes regular and ſometime irregular.

EXPERIMENT III.

July 6. 76.

Gooſberries in Compreſs'd Air.

GOoſberries included in a Receiver with as much Air as rais'd Mercury ⅛ of an Inch; in half an hour it was rais'd half an Inch more; in 7 hours it was rais'd to 5 Inches.

July	7		5	*July*	10		4¾	Digits
	8	It roſe	3⅛		11	It roſe	4	high.
	9		3¾		12		4	

The

July 13.

The Cover was broke; and another ſubſtituted in it's Place.

July 14, 15, 16, 17, 18.

There was no Change: The Fruit being taken out, Part was ſhut up in *Vacuo*; the reſt with common Air. In four hours the Aſcent of the Mercury was 4 Digits.

July 19.

The Mercury aſcended $\frac{1}{3}$ in 14 hours; but becauſe I ſuſpected that ſome Air got out, I ſet the Screw, and in 9 hours the Mercury roſe 11 Inches. The Cover broke and the Air was loſt.

Hence it appears, that unfermented Goosberries contain much Air, which they more readily afforded, when the Preſſure of the Air, is taken off; tho when fermented they yield a great deal more in Compreſs'd Air.

EXPERIMENT IV.

July 8. 76.

SWollen Paſte being included with as much Air as rais'd Mercury, by the Preſſure of that, loſt a third Part of it's humidity. Soon after it ſwell'd again, and in half an hour rais'd the Mercury two Digits. *Paſte in Compreſs'd Air.*

The Paſte continu'd to ſwell, and the Mercury in an hour was rais'd $2\frac{1}{2}$. In an hour more it was rais'd $3\frac{1}{3}$ and in another $4\frac{1}{3}$. It ſtaid at 16 Digits.

July 9.

In 14 hours it was rais'd 21 Inches high, and ſtood at 37. the Screw being ſet to prevent Air from getting out, the Cover broke, and upon an Ingreſs of Air, the Paſte ſubſided 2 Digits, tho' the Compreſſion was leſs than before.

In 5 hours Space the Mercury aſcended 13 Digits. But the Screw being ſet, the Cover broke again, ſo that the Air got in, and depreſs'd the Paſte again.

In 4 hours the Mercury aſcended 10 Digits, and the Paſte roſe as before; But being willing to make uſe of another Screw, I permitted a little Air to get out.

July 10.

The Paſte roſe again this Night, but yielded no Air. In 7 hours time the Mercury aſcended 4 Inches. *July* 13 A little Air was produced.

July 17.

The Paſte being taken out, was ſubacid in Smell. Hence it appears, that Paſte may yield Air in Compreſs'd Air, as well as in *Vacuo*. The riſing of the Paſte ſeem'd to depend on the Expanſion of the Air in the Paſte, which was depreſs'd and over-power'd by the External Air, when it was let in.

EXPERIMENT V.

July 13. 76.

BEANS, ſuch as Horſes eat, being ſhut up with Water in *Vacuo*, thoſe that were bruis'd, ſeem'd to ſwell; thoſe which were whole, ſeem'd unalter'd. The Mercury, *Beans ſhut up in a Receiver.*

July 14		7	*July* 21		$5\frac{1}{2}$
15		5			2
16		3	22	It roſe	78
17	roſe	6	23		5 *i. e.* 35
18		9	24		Above the
19		1			wonted Preſ-
20		$3\frac{1}{2}$	25		ſure.

The Receiver was not able to bear a greater Preſſure. The Beans were very fetid, like putrify'd Fleſh.

Beans yield Air in a moderate Preſſure, as well as in *Vacuo*, ſometimes ſooner, and ſometimes ſlower.

EXPERIMENT VI.

July 23.

GOosberries ſhut up in *Vacuo*; and in 2 hours the Mercury aſcended 1 Inch. *Gooſberries in* Vacuo.

July	24	It aſcended to	7½	*July*	29	It aſcended to	30
	25		12		30		31 almoſt. Some Air being tranſmitted out of this into another Receiver, it ſtood at 26.
	26		17				
	27		20				
	28		24½				

31 The height was 35.

Auguſt 1.

Some Air got out, and whilſt I endeavour'd to ſtop the Receiver cloſe, the Mercury that was rais'd to 39 Inches, ſubſided to 30 Inches.

Aug.	2	The height of the Mercury was	39. Some Air being tranſmitted, it ſtood at 31.
	3		39
	4		41
	5		43. Air tranſmitted it ſtood at 30
	6		43
	7		47
	8		48. Air being tranſmitted, it ſunk to 36.

Aug.

Aug.	9			41.			
	10			47. Air being tranſmit-			
	11			mitted, it ſtood at 35.			
	12			38½.			
				42 The Air was drawn			
		The height		out, and the Mercury			
	13	of it was		was 26 Inches high.			
	14			33	*Aug.*	17	44
	15			36		11 The height	47
	16			39		19 was	50
				41½			

The Air being tranſmitted, and the Gooſberries taken out, they had loſt their Colour, and almoſt all their Acidity. They produced Air very regularly, except a little faſter, when ſome part had been drawn out.

EXPERIMENT VII.

Sept. 12.

CRUDE Grapes were put into a Receiver, with as much Air as rais'd Mercury 3 Digits. *Crude Grapes.*

Sept. 13		5		*Sept.* 29		37¼
14		10		30		37¾
16		17		*Oct.* 2		35⅓
17		19		4		35⅓
19	The	23		5	The	40⅓
20	hight	25		7	hight	41⅓
22	was	30	It was stop'd	9	was	42⅓
23		31	with a	15		46
24		32	Screw	*Nov.* 2		54
26		34½		5		58
27		36¼		*Jan.* 10		70
28		36¼				

There was no sensible alteration in the Gage when the Frost was most severe, tho' the Grapes and their Juice was Froze.

Sept. 21.

The Grapes being little alter'd, and the Mercury not much higher, the Receiver was open'd, and the Grapes tho' more pungent, had not lost their Taste, but their Juice preserv'd it's red Colour.

Hence it appears, that Grapes yield not all their Air in a little time.

EXPERIMENT VIII.

August 10. 77.

Pears in Vacuo.

PEars cut in two being included in a *Vacuum*, about Evening the Mercury was rais'd 10 Digits.

Aug.

Aug. 11	It	20		*Aug.* 15	It	55
13	roſe	38		16	roſe	60
14	to	48		17	to	68

Air being Tranſmitted it ſubſided to 53½.

Aug. 18		61	
19		64	
20		70	
21		72	Air being tranſmitted it ſtood at
22		68	61.
23		74	
24		79	
25		81	Air being tranſmitted it ſunk to 61.
26		56	Some got out; being tranſmitted
27		60	it ſunk to 52.
28		68	
29	The hight	75	
30	was	83	
31		88	
Sept. 1		93	
2		100	
3		89	Some Air got out.
4		100	
5		100	
7		100	No Air got out.
9		107	
10		107	Air being Tranſmitted it ſunk to
11			99.
13		105	

Oct. 8 Air got out. Pears yielded their Air by fits.

A R-

ARTICLE XI.

Various Experiments.

EXPERIMENT I.

March 16.

Melted Lead in a Receiver.

LEad being melted in a Braſs Veſſel, an Inch and ½ in Diameter, it was conveigh'd into a Receiver, and the Air pump'd out, before the Lead cool'd; when it was cool the Surface was concave, eſpecially in the Middle; tho' when it cools in open Air, the Surface is generally convex, except in the Middle.

The ſame ſucceſs happen'd when the Experiment was made with Tin. Neither of the Metals afforded Bubbles.

EXPERIMENT II.

Sept. 2.

A Solution of Salt in Water.

A Solution of Salt in Water being conveigh'd into a Receiver.

Sept. 15.

The Salt was not Chriſtaliz'd.

EX-

EXPERIMENT III.

Auguſt 8. 76.

ARtificial Air from Gooſberries was included in a Receiver. *Artificial Air.*

March 1. $7\frac{8}{9}$.

No Alteration in the height of the Mercury.

EXPERIMENT IV.

Auguſt 8.

A Phial which was large enough to hold 7 Ounces 5 Drachms and 3 Grains of Water, having the Air exhauſted, was pois'd to an *Æquilibrium* with another weight. Upon which a Piece of a Bladder which cover'd it, was pierc'd with a Needle, and the Air getting into it, weigh'd 4 Grains & $\frac{1}{3}$, which Weight is to the former, as 1 to 814; ſo that Water is 800 times heavier than Air of the ſame Bulk. *Air weigh'd.*

EXPERIMENT V.

Jan. 16. 77.

A *Qua fortis* and fix'd Nitre, being mix'd in a Receiver together, yielded much Air. *Aqua fortis and fixed Nitre.*

March 5.

The Air was not deſtroy'd, nor the height of the Mercury alter'd. But Nitre was produc'd in *Vacuo* from the Mixture.

EX-

EXPERIMENT VI.

May 12. 76.

Several Bodies in Vacuo.

A Phial which had a long Neck, being ſo far fill'd with Oyl, that it wrought up to the middle of it's Neck, was conveigh'd into a Receiver; and ſo much Air Compreſs'd into it, as rais'd the Mercury 120 Inches above the uſual height.

The Surface of the Oyl ſubſided ¼ of an Inch, being condens'd by Cold; which was evident, ſince the compreſs'd Air being let out, the Surface roſe not again.

Auguſt 5.

The ſame Experiment being made with Water, there was no ſenſible Alteration in the height of it's Surface, tho the heat might have given reaſon to expect ſome change.

Jan. 14. 78.

A Glaſs Phial being fill'd with Spirit of Wine, till it roſe within 3 Inches of the Top of it's Neck, was by the heat of my Hands, caus'd to riſe to the top of the Veſſel: Which being then Invert'd into a Veſſel full of Mercury, and my Hands remov'd, the Cold Spirit admitted 3 Inches of Mercury into it's Neck; yet being conveigh'd into a Receiver, and ſo much Air compreſs'd into it, as rais'd 90 Digits of Mercury, the Spirit was not in the leaſt condens'd by compreſſion, tho Cold had ſuch a conſiderable effect on it. When the Receiver was open'd there was no appearance of Bubbles in the Spirit of Wine.

Wine. It would be worth while to conſider, why Cold ſhould have ſuch a conſiderable Effect in condenſing Spirit; and why it cannot be condens'd by Compreſſion.

EXPERIMENT VII.

May 12. 76.

Spirit of Wine and Oyl of Turpentine.

SOme Spirit of Wine contain'd in a Glaſs Veſſel, with ſome drops of Oyl of Turpentine upon it, were briskly mov'd about, till the Receiver being exhauſted, they ſtuck to ſeveral Bubbles which roſe out of the Spirit of Wine, and were by them carri'd to the ſides of the Veſſel; where they were kept, except 2 Drops, which the Bubbles left behind upon the Surface of the Spirit; which, whilſt the Receiver was exhauſting, continued their Motion, but in a little time after, were wholly at reſt. Yet upon a Re-ingreſs of Air, they for a little while renew'd their Motion again.

The ſame Experiment being repeated with Spirit of Wine and Oyl of Turpentine, wholly freed from Air; there was neither any Ebullition, nor an appearance of Bubbles; yet the Drops of Oyl mov'd in *Vacuo* after the ſame Manner as in open Air.

Hence it appears, that the Motion of the Parts of Oyl, depend not in a Diſſolution in *Vacuo*; ſince all Diſſolutions are company'd with a production of Bubbles.

EX-

EXPERIMENT VIII.

May 19. 76.

Radiſhes in a Receiver with Claret.

HAving cut two Radiſhes tranſverſly, and ſuſpended them all Night in *Vacuo*, over a Veſſel of Claret, the ſmall End of one being downwards, and the other in a contrary Poſture; all being freed of their Air, the next Day I freed two other Radiſhes from their thick Skin, and cutting them tranſverſly, ſuſpended them over the Wine, as the others, in *Vacuo*; upon which, immerſing them all in the Wine, they emitted Bubbles conſiderably; eſpecially, thoſe that had been longeſt in the Receiver.

From this Experiment we may urge, that Bubbles are form'd of Particles of Air contain'd in Water; and the Reaſon why thoſe Radiſhes yielded moſt Air, whoſe Skins were not pull'd off, is, becauſe thoſe Skins are full of Canals and Pores, to contain Air, in for the forming of Bubbles.

The Liquor aſcended equally in all the Radiſhes, notwithſtanding their Poſtures.

EXPERIMENT IX.

May. 4.

A ſmall Tube immers'd in Water.

A Small Glaſs Tube open at both Ends, being immers'd in Water, the Water in *Vacuo*, aſcended as high as it uſually does in common Air; but in a little time it was rais'd higher,

er, by Bubbles of Water, which divided and intercepted the Cylinder of Water in 3 ſeveral places; beſides, ſeveral Bubbles of Water paſs'd out at that End of the Tube which was immers'd.

One End of this Tube being Hermetically ſeal'd up, the Experiment ſucceeded after the ſame manner, as when it was open; but in the open Air, the Water aſcended not.

One thing in this Experiment was very Remarkable, *viz.* That the Water ſuſpended in the Tube, yielded no Bubbles, but only at the Bottom of the Tube; nor did the Cylinder of Water even at the Bottom yield Bubbles, when it was rais'd above the Surface of the Water which it was before immers'd in.

May. 5.

The Experiment was repeated; but before the End of the Tube was immers'd in Water, a Drop, which ran over the Superior Aperture of the Receiver, fell down to the open End of the Tube, and was rais'd two Lines in the Cavity of the Pipe: No Bubbles were form'd in half an hour, till the Tube was immers'd in Water, and then ſucceſſively they roſe one after another. In trying this Experiment, ſeveral times I obſerv'd, that tho', whilſt the Tube was immers'd, ſeveral Bubbles appear'd about the End of it, yet when it was rais'd above the Surface of the Water, none were to be ſeen.

May 6.

The Experiment was try'd with an Infuſion of Nephritick Wood; in which the Succeſs was alike, except that in the Infuſion, when the Bubbles

bles were ſmall, they aſcended to the Top of the Liquor, which is an Argument of it's Thinneſs, and that it hath no Viſcocity.

May 10.

I repeated the ſame Experiment, with a Mixture of Spirit of Wine, and an Oyl made *per Deliquium*; In which nothing was to be obſerv'd different from the former, but that the Liquor aſcended not ſo high.

From theſe Experiments it may probably be inferr'd, That the Formation of Bubbles in the Extremity of the Tube, depends on aerial Particles, which ſwim in the Water, and meeting with ſome Impediment at their End, are kept there, till new ones joyning with them, form Bubbles.

EXPERIMENT X.

July 18. 76.

Beans with Water in an Iron Tube.

BEANS, ſuch as Horſes eat, being ſhut up with Water in an Iron Tube 2 days ago, to day ſeem'd unalter'd; but the Stopple of the Tube being pull'd back, Air and Water broke out; which Eruption was ſucceeded by a bubling Noiſe, which continu'd above an hour.

July 25.

The Iron Tube was open'd a ſecond time, and a bubling Noiſe ſucceeded as before.

Whence it appears, that Beans contain Air, which cannot diſcharge it ſelf in a Compreſſion, till that Compreſſion is remov'd.

EX-

EXPERIMENT XI.

March 4. 77.

Spirit of Sal Armoniack and Copper.

A Glaſs half full of Spirit of *Sal Armoniack*, being included in *Vacuo*, with Filings of Copper in it, in 15 Minutes it was tinged with a diluted Blew, which, upon an Ingreſs of Air, in 3 Minutes became vivid and thick.

April 4.

The Liquor having been enclos'd in *Vacuo*, had almoſt loſt it's Colour, which it regain'd when the Air was let in again.

EXPERIMENT XII.

May 8.

Oyl per Deliquium with Spirit of Wine.

OYL made *per Deliquium*, being ſhut up in a Receiver, with Spirit of Wine ſwimming upon it; when the Air began to be exhauſted, great Bubbles roſe from the Spirit, and ſmall ones from the Oyl; but in an hour, the Oyl afforded Bubbles large enough to fill the whole Diameter of the Pipe in their Aſcent, and an hour after that, they broke out ſo violently, as to ſtrike againſt the Top of the Receiver.

May 9.

The Experiment being repeated in a Veſſel, which was longer and narrower, I obſerv'd, that the Bubbles which roſe from the Oyl, were not very large, till ¼ of an Inch above the Sur-

face of it, and then they were ſuddenly expanded.

EXPERIMENT XIII.

May 3. 76.

Aq. Fort. and Spirit of Wine.

A Mixture of *Aqua Fortis* and Spirit of Wine, being divided into three Parts, and each of thoſe included in a diſtinct Veſſel with a piece of Iron, one of them was included in *Vacuo*; upon which, ſeveral conſiderable Ebullitions ſucceeded. The Liquor when taken out, was black and Turbid; tho' in the other two, it was not alter'd in Colour, but only a black Powder was ſettled in the Bottom. Wherefore one of thoſe being included in *Vacuo*, after Ebullitions, leſs violent than thoſe in the Veſſel firſt included, the Liquor in a quarter of an hours time, being taken out, was almoſt as black and turbid, as that firſt put into the Receiver: That in the open Air, was not much alter'd.

May 4.

The Liquors ſhut up in the Receivers, appear'd clear and green; But that in the open Air, bubbled more than the day before, and was of a red Colour: And all three being ſhut up in *Vacuo*, the red Liquor afforded larger Bubbles.

Hence it appears, that Spirit of Wine promotes Ebullition in *Vacuo*.

EP.

EXPERIMENT XIV.

Jan. 21. 78.

Spirit of Sal Armoniack with Filings of Copper.

A Glaſs half full of Spir. *Sal Armon.* with Filings of Copper, ſtopp'd with a Leather Stopple, was put into a Receiver, with unfermented Paſte.

Jan. 22.

The Air yielded by the Paſte, penetrated the Leather, which is impervious to common Air, which appear'd by the Tincture it gave the Liquor.

Jan. 25.

The Liquor had almoſt loſt it's Colour; ſo that the Particles of Artificial Air are ſo minute, as to penetrate Pores which common Air cannot.

Feb. 2.

The Glaſs being ſhut up in a Receiver, which admitted Air ſo gradually, as to be fill'd in 24 hours, the Liquor ſtill remain'd Colourleſs.

Feb. 15.

The Glaſs being again ſhut up in *Vacuo*, with Paſte, the Air afforded by it, did not as before, penetrate the Leather; nor was the Liquor in the leaſt tinged by it.

EXPERIMENT XV.

April 2. 78.

A Shrew-Mouſe in Vacuo.

HAving put a Shrew-Mouſe into the Engin deſcrib'd, for the Filtration of Air through Water; when the Pump was ſtirr'd, and the Air began to penetrate the Water, it was a little better; but could not recover.

Apr. 12.

The Experiment was repeated with a weakly Mouſe, that had been kept faſting a long time; the Succeſs was the ſame as in the laſt Experiment; for the Mouſe being taken out before it was dead, could not recover in the free Air.

EXPERIMENT XVI.

May 2. 78.

Spawn of Frogs in Vacuo, &c.

SIX Weeks ago, Spawn of Frogs being included in common Air, in *Vacuo*, and in another Receiver with compreſs'd Air, which ſuſtain'd 60 Digits above the ordinary height.

The Mercury in *Vacuo*, in 15 days was rais'd 1 Inch. The Spawn in common Air, was corrupt and blackiſh; that in the compreſs'd Air remain'd unalter'd.

A Month after, the Spawn in *Vacuo* was turn'd into Water, except the black Spots; but had not alter'd it's Colour. That in the common Air was very black; That in the compreſs'd Air began to be reddiſh; which Colour ſenſibly increas'd.

May

May 22.

That in the common Air had loſt it's Colour.

June 23.

That in the compreſs'd Air had acquir'd a Greenneſs.

Octob. 15.

That in *Vacuo* was exhaled out of it's Veſſel, and remain'd in the Receiver in the Form of Water: That in the common Air was void of Colour; and that in the compreſs'd Air was ſtill red.

EXPERIMENT XVII.

May 9. 78.

AN Orange having been divided, and included in two Receivers, in which was left an equal Vacuity; the Capacity of the larger being ſo far fill'd with Water, as it was bigger than the Cavity of the other, I obſerv'd, that that which was ſhut up with Water, was four times more mouldy than the other. *Oranges in Vacuo.*

The ſame Experiment was repeated, the third part of the Cavity of one Receiver being fill'd with Water, yet the Orange was not touch'd by it. *June* 15. Neither of the Pieces of the Orange was mouldy, and the ſame Experiment being again repeated, neither Piece was mouldy in a Months time.

The Difference ſeems to be the Effect of ſome Diſpoſition in the Air.

EXPERIMENT XVIII.

June 1. 78.

Venice Turpentine in a Wind-Gun.

A Small Glaſs Tube, half full of *Venice* Turpentine, being put into the Wind-Gun, as ſoon as the Air was compreſs'd into a tenth Part of the Space it poſſeſs'd before; The Leather which cover'd the Elliptick Hole was driven out. The Tube being taken out, I perceiv'd ſeveral Bubbles in the Top of the Turpentine, which I ſuppos'd, had been preſs'd into it when the Cavity of the Gun had Air compreſs'd in it; Therefore placing the Tube again in the Gun, I caus'd the Air to be condens'd to 15 times as little compaſs.

June 3.

The Turpentine being taken out, was free from Bubbles, but by degrees, a great many were form'd in it.

June 4.

Having freed Turpentine from it's Air, and pour'd Water upon it, I ſhut up all in the Wind-Gun.

June 8.

At the firſt ſight, both the Water and Turpentine were free from Bubbles; but ſoon after they appear'd and aſcended in the Turpentine, almoſt from the Bottom: So that the Air that form'd theſe Bubbles penetrated the Water and moſt of the Turpentine.

EX-

EXPERIMENT XIX.

Aug. 11. 78.

WHEN Spirit of *Sal Armoniack* was clear'd of it's Bubbles, I mix'd Filings of Copper with it in *Vacuo*; upon which, it yielded ſeveral Bubbles; they did not yield Air, but deſtroy'd what was contain'd there before; The Liquor was green and turbid. *Filings of Copper and Sp. Sal Armon. in Vacuo.*

Decemb. 5.

The Spirit was for the greateſt part got out of the Veſſel, and condens'd in the Receiver; that which continu'd in the Veſſel, was as clear as Water. The Mercury was wholly driven out of the Gage; whence it was reaſonable to ſuppoſe, that the Air was gradually conſum'd in the Receiver.

EXPERIMENT XX.

Septemb. 2. 78.

A Cylinder of Tin, and another of Lead, being immers'd in *Vacuo* in Mercury, and two others in Mercury expos'd to common Air. *Mercury rais'd in a Tube in Vacuo, &c.*

Sept. 6.

The Mercury in the Tin Cylinder in *Vacuo*, was rais'd 4 Inches and a half. The Pipe being cut tranſverſly, half of that Space above the Mercury it was immers'd in, and in another place an Inch above the Surface of the Mercury, the *Amalgama* had penetrated into the Metal half a Line above, and a whole one below.

The Mercury in the Lead Pipe had not ſenſibly penetrated into that Metal, except where it was immers'd: It was rais'd in it 2½.

Sept. 7.

The Mercury had aſcended 5 Digits in the Tin Pipe, which was expos'd to the Air.

Sept. 10.

The ſame Cylinder continuing in the Mercury, was beſmear'd up to the very Top, 6 Inches above the Surface of the ſtagnant Mercury, which had penetrated the Tube the deeper, by how much the nearer the ſtagnant Mercury, ſo that near the Surface it had penetrated 3 Lines deep.

The Mercury was not rais'd above 3 Digits and a half in the Lead Pipe, nor had it made any ſenſible Penetration: So that the Preſſure of the Air contributes little to the Aſcent of Mercury into Metals.

EXPERIMENT XXI.

Decemb. 12. 78.

A Whiting in Vacuo.

THE Head of a Whiting being cut off, and divided into 5 parts, one of them was ſhut up in *Vacuo*; another in common Air, another in compreſs'd Air, which ſuſtain'd 50 Digits above the uſual height. The fourth was included with Air from Paſte, the laſt piece was expos'd to open Air.

Decemb. 15.

That in the open Air, in the Morning began to ſhine; and in the Evening, yielded a Light more vivid.

Decemb.

Decemb. 16.

It gave over ſhining till Evening.

Dec. 17. It ſhined a little. *Dec.* 18. at Night it ſhone a little.

Dec. 20. It continu'd to ſhine. *Dec.* 22. It ceaſed.

Dec. 23. That included in common Air, began to ſhine. The 24. It did not.

Jan. 26. 79.

None of them ſhined.

ARTICLE XII.

Artificial Air *deſtroy'd.*

EXPERIMENT I.

Auguſt 3. 77.

ARtificial Air of Cherries being tranſmitted into a Receiver full of common Air, till the Mercury was rais'd 25 Inches above it's uſual height. *Artificial Air of Cherries deſtroy'd.*

Aug. 4	It ſunk to	23		*Aug.* 8	a little		
6		20		10	to 19½		
7							

EX-

EXPERIMENT II.

May 26. 76.

Artificial Air generated and deſtroy'd.

SIX Grains of *Sal Armon.* being let fall into a ſufficient Quantity of Oyl of Vitriol in *Vacuo*; there follow'd a great Ebullition, ſo that the Mercury roſe to it's uſual height, but preſently ſubſided again.

May 27.

The ſame Experiment being try'd, with this difference, *viz.* that the Salt was kept 10 hours in *Vacuo*, before it was dropt into the Oyl; the Succeſs was, that it was 7 or 8 hours before the Air generated by the Ebullition, was deſtroy'd.

May 29.

The Salt being not mix'd till after 24 hours, the Ebullition and Quantity of Air generated, were leſs, and more ſlowly produc'd; and it was obſervable, before the Ingredients were mix'd, that the Mercury rather ſubſided in the Gage, as if ſome Air had been drawn out.

July 8.

Oyl of Vitriol being included with a fifth Part of common Air, rais'd the Mercury a little, and kept it up 24 hours.

From whence it appears, that Artificial Air may be deſtroy'd.

A R-

ARTICLE XIII.

Experiments concerning the different Celerity of Air *produc'd in* Vacuo, *or in Common* Air.

EXPERIMENT I.

Common Air.

July 1.0 77.

SOwriſh Paſte being included in a Receiver, In an hour the Mercury was rais'd an Inch; in 7 hours 6 Digits. *Air from ſours Paſte.*

July 11		11		*July* 15	It aſcended a little. and was 38 Inches high.
12	The height	24			
13	was	30			
14	Senſibly greater.			19	It yielded no more Air.

Vacuum.

July 10. 76.

A leſs Quantity being enclos'd in *Vacuo*, in an hour the Mercury aſcended 2 Inches, In 7, it was rais'd to the Top of a ſhort Gage.

July 19.

The Cover was not ſeparated from it's Receiver; but the Paſte being fired by a Burning-Glaſs, it's Superficies was tinged yellow by the Fumes

Fumes, which after their Aſcent fell upon it, ſo much Air was produc'd, that the Cover was eaſily remov'd from the Receiver.

EXPERIMENT II.

Common Air.

Auguſt 20. 76.

From Paſte 24 hours old.

PASTE 24 hours old, being included with as much Air as rais'd Mercury 4 Digits and ½ above it's uſual height. In 6 hours, it was rais'd to 8 Inches.

Aug.	21	It roſe	4½	*Aug.*	27	It aſcended not.
	22		1		29	It ſmell'd ſubacid.
	23		½			
	26		½			

Vacuum.

Aug. 20.

Paſte being enclos'd in *Vacuo*, the Mercury was preſently rais'd 2 Inches.

Aug.	21	It roſe	5	*Aug.*	26	It roſe 2 *in* 3 days.
	22		3		27	0
	23		1		28	The Paſte was taken out.

Hence it appears, that ſometimes Air is more eaſily produced in *Vacuo*, than common Air.

EX-

EXPERIMENT III.

Vacuum.

Septemb. 4. 77.

FILBERD Kernels were enclos'd in common Air. *From Filberd Kernels.*

Sept.				*Sept.*			
	5		5		12		23
	6		10		13		27
	7	The height	10		14	It	29
	8	was	12		15	was	a little
	9		15		17		more.
	11		18				30

Sept. 18.

Some Air got out; ſeveral Bubbles appearing in the Turpentine, which guarded the Joynts of the Receiver.

Common Air.

Sept. 4.

In the Afternoon the Air ſeem'd to be diminiſhed.

Sept.				*Sept.*		
	5		almoſt $\frac{1}{2}$		8	No Alteration.
	6	It was	the ſame		18	
	7		1 Inch.			

EXPE-

EXPERIMENT IV.

Septemb. 15. 77.

EIGHT Ounces of Raiſins of the Sun, bruis'd and diluted with Water, being included in a Receiver, large enough to hold 22 Ounces of Water.

Sept. 16	The height was	6	*Sept.* 19	It was	29
17		10	20		
18		15			

21 The Receiver forc'd from the Cover.

Sept. 24.

Some Raiſins being taken out, the reſt were ſhut up in *Vacuo*. *Sept.* 25. The Receiver was ſever'd from it's Cover.

Sept. 15. 77.

The ſame Ingredients being ſhut up in common Air.

Sept. 16	The height was	$\frac{1}{5}$	*Sept.* 21	The height was	9
17		$1\frac{1}{2}$	22		11
18		3	23		12
19		5	24		15
20		7			

When the Air broke out, ſeveral Bubbles roſe from the Raiſins: Hence it appears, that Air is more eaſily generated ſometimes in *Vacuo*, than in common Air.

EX-

EXPERIMENT V.

Vacuum.

Feb. 17. 77.

THREE Onions being enclos'd in *Vacuo.* Onions in Vacuo.

Feb. 19	The Aſcent was	1		*May* 4	They were not alter'd.	
21		1		18		
25		9		*Jun.* 19	The Onions rotten.	

Rarified Air.

Feb. 17.

Three Onions were enclos'd in Air, ſo far rarifi'd, that it ſuſtain'd only 10 Digits of Mercury.

Feb. 19.

The Mercury aſcended not. 21. They had acquir'd a Mouldineſs. 25. The Mercury aſcended 7 Digits.

May 4.

No Alteration in the Onions. 18. No Alteration in the Onions, but the Receiver was forced from the Cover.

Common Air.

Feb. 17.

Three Onions were included in a Receiver, not exactly ſhut.

Feb. 21. They were not mouldy; but budded. 25. They ſhot forth their Roots.

May

May 4.

They began to be Mouldy.

This Experiment ſhews, that ſome Bodies yield Air as well in rarified Air as in *Vacuo*. As alſo that Vegetation is promoted by Air. It is here likewiſe worth our Notice, that whilſt the Onions ſhot forth, they did not grow Mouldy

ARTICLE XIV.

EXPERIMENT I.

Bruis'd Fruits.

Auguſt 23. 77.

Bruis'd Pears in Vacuo.

BRuis'd Pears being included in an exhauſted Receiver.

Aug. 25	The height was	5	*Aug.* 29	The height was	21
26		10	30		25
27		14	31		28
28		18	*Sept.* 1		30

Sept. 2.

Receiver was ſeparated from the Cover.

Whole Fruit.

Auguſt 23.

Whole Fruit.

The ſame Quantity of Pears being proportionably included in a Receiver.

Aug.

Aug. 25	The	11	*Aug.* 28	It was	28
26	height	17	29		33
27	was	25	30	The Receiver was forc'd from it's Cover.	

Hence it ſeems, that entire Fruit yielded Air ſooner than Bruis'd ones.

EXPERIMENT II.

Auguſt 24.

WHole Apples being included in a Receiver exhauſted. *Whole Apples in Vacuo.*

Aug. 25		5	*Aug.* 30		25
26	It	9	31	It was	28
27	was	12	*Sept.* 1		29
28		15	2		30
29		19	3	The Receiver ſever'd from the Cover.	

Auguſt 24.

An equal Quantity of bruis'd Fruit being put into a Receiver.

Aug. 25		1	*Sept.* 3	
26	It was	3	25	The ſame.
27		4		

This Experiment is a Confirmation of the Inference drawn from the laſt.

EXPERIMENT III.

August 25. 77.

Bruis'd Grapes in Vacuo.

BRuis'd Grapes were ſhut up *in Vacuo.*

Aug. 36		1		*Aug.* 29		$2\frac{1}{2}$	
27	It was	2		*Sept.* 15		$2\frac{1}{2}$	
28		$2\frac{1}{2}$					

Auguſt 25. 77.

Unripe Grapes whole were ſhut up in a Receiver.

Aug. 26		3		*Aug.* 31			13
27		5		*Sept.* 1			15
28	It was	7		2	It was		16
29		10		3			18
30		12		4			18

Sept. 5.

They began to be Yellow. *Sept.* 7 They grew Yellow; the Mercury was 18 Inches. *Sept.* 15 it was 20.

This is a further Confirmation of the former Experiment.

EXPE-

EXPERIMENT IV.

Sept. 10. 77.

TWO Ounces of ripe Grapes being included in a Receiver capable of holding 10 Ounces. *Ripes Grapes.*

Sept. 11		6
12		9
13		12
14		15
15		20
16		25
17		28
18	It was	30 The Grapes unalter'd.
19		30
20		Grapes a little riper.
21		The Receiver was forc'd from the Cover.
Sept. 22		The Grapes beginning to Rot, were ſhut up in another Receiver.
23		5
24		9
25		14
26	It was	17
27		20
29		27
30		28
Oct. 10		The Receiver forc'd from the Cover. The Grapes ſeem'd rotten; but preſerv'd their Firmneſs.

Sept. 10. 77.

The ſame Quantity of bruis'd Grapes being included in a Receiver of the ſame Size.

Sept. 11		4
12	It was	7
13		10
14		12
Sept. 15		15
16	It was	18
17		20
18		25

Sept. 19.

A good Quantity of the Juice was Spilt, the Receiver being ſever'd from the Cover.

Sept. 20.

The ſame Grapes were ſhut up with as much Air as rais'd the Mercury 3 Inches.

Sept. 21.

The Receiver was ſeparated from the Cover; and the Grapes enclos'd in another Receiver with common Air.

Sept. 22.

The Mercury was 11 Inches high.

Sept. 23	It	19	*Sept.* 30	It was 20	
24	was		*Oct.* 3	Being taken out they were bitter.	

Ripe Grapes yield more Air when bruis'd, than unbruis'd.

EXPERIMENT V.

Nov. 19. 78.

Sound and bruis'd Apples in Receivers.

A Sound and a bruis'd Apple, being each put into a diſtinct Veſſel; Another bruis'd one was put into a third; which was ſo adapted to it, that when the Receiver was exhauſted, the Air form'd in the bruis'd Apple expanding it ſelf, ſqueez'd out the Juice.

Nov. 22.

In the firſt Receiver the Mercury was 5: In the ſecond 3: In the third 0.

Nov.

Nov. 23.

In the 1*ſt* 7 Inches: In the others no Alteration.

Decemb. 7.

In the 1*ſt* 11: No Alteration in the others.

Jan. 23.

The firſt ſeparated from the Cover.

May 20. 79.

The third ſeparated from the Cover: In the ſecond no Air produc'd.

The Reaſon why bruis'd Fruits yield moſt Air in *Vacuo*, ſeems to be, becauſe they there have more Liberty to expand their Parts.

ARTICLE XV.

Air is ſometimes found unfit to produce Mouldineſs.

EXPERIMENT I,

July 12. 78.

ROſes being included in two Receivers, and as much Air with one of them as ſuſtain'd 60 Digits of Mercury. *Roſes in Common and Compreſs'd Air.*

Auguſt 2.

Thoſe in Common Air turn'd Yellow, the others retain'd their Colour.

Feb. 10. 79.

Thoſe in the Compreſs'd Air were unalter'd. This compar'd with *Exp.* IV. *Art.* IV. ſhews, that ſeveral times the Air is ſo different, as ſometimes to hinder and ſometimes to promote Corruption.

EXPERIMENT II.

May 22.

Tulips and Lark-Spurs. TUlips and Larks-ſpurs being ſhut up in two Receivers, and as much Air compreſs'd in One as ſuſtain'd 60 Inches of Mercury 15 Days ago.

In five days ſome of the Tulips in the Common Air that were cut, ſeem'd Mouldy. To day the other part ſeem'd Mouldy.

The Flowers ſeem'd as freſh as when firſt put in; but thoſe in Compreſs'd Air were more moiſt.

June 22.

No more Mouldy: This Experiment compar'd with the ſame made the Year before, confirms the Inference drawn from the foregoing.

ARTI-

ARTICLE XVI.

Experiments concerning the Change of Weight, made in the Beams of the Sun, even in Veſſels ſeal'd Hermetically.

EXPERIMENT I.

Sept. 4. 78.

Minium expos'd to the Sun Beams.

A Drachm of Minium being expos'd to the Sun Beams, concenter'd by a burning Glaſs loſt $\frac{1}{4}$ part of a Grain.

EXPERIMENT II.

Sept. 6.

Calcin'd Coral expos'd to the Sun Beams.

CAlcin'd Coral being expos'd to the Beams of the Sun in a Glaſs hermetically ſeal'd, became whiter.

Sept. 10.

In two hours, the Glaſs being weigh'd, it from the firſt had loſt $\frac{1}{11}$ of a Grain.

EXPERIMENT I.

May 23.

Calx of Tin in a Glaſs Hermetically Seal'd.

CAlx of Tin included in a Glaſs hermetically Seal'd, loſt $\frac{1}{24}$ part of a Grain, by the Effects of the Sun Beams concentred by a burning Glaſs.

May 29.

The Experiment being tried with Minium, it loſt $\frac{1}{3}$ part of a Grain.

May 30.

Being about to repeat the Experiment, the Glaſs flew in Pieces.

June 6.

The ſame Experiment being tried with Minium it loſt $\frac{1}{4}$ part of a Grain. Upon a ſecond tryal the Glaſs broke.

July 15.

The Sun had no effects on Coals of Wood.

June 20.

The Sulphur *Vive* tho' it melted and fum'd, loſt none of it's Weight.

Auguſt 1.

The ſame Experiment being repeated it loſt no Weight.

ARTICLE XVII.

The Preſervation of Bodies in Compreſs'd Liquors.

EXPERIMENT I.

Aug. 3. 78.

An Apricock in Water.

AN Apricock was ſhut up in one Receiver full of Raiſins of the Sun ſton'd; Another being conveigh'd into a Second, ſo that it neither touch'd the Water nor Raiſins.

Sept.

Sept. 10.

The Apricock enclos'd in the Water being taken out, bubbled whilſt the Air made it's way out. The Apricocks had a pleaſant Reliſh, but the Raiſins had loſt their Taſte.

Feb. 10. 78.

The other Apricock only ſeem'd to have loſt it's Firmneſs. Some Fruits may reſerve their Taſte in an Infuſion of Raiſins of the Sun, if the Veſſel will bear a great Compreſſion of Air.

EXPERIMENT II.

Sept. 17 78.

PEACHES being included in 2 Receivers, with an Infuſion of Raiſins. *Peaches included in Artificial Air.*

Sept. 11.

The Air generated in one Receiver, forc'd out ſome of the Air.

Sept. 25.

More of the Liquor was forc'd out, ſo that a fifth part ſeem'd empty; but the Screw being ſet, it was preſerv'd. *Sept.* 26. The ſame Receiver leak'd again.

Nov. 27.

The Receiver being open'd, whilſt the Air made it's way out, the Peaches bubbled: The yellow ſort were ſoft, but preſerv'd their Taſte; the other ſort reſerv'd it's Firmneſs. The Liquor was very grateful and pleaſant.

Decemb. 28.

The other Receiver being open'd, tho' before it ſeem'd unalter'd, yet both the Liquor and Peaches

Peaches bubbled. One ſide was ſoft, the other hard: It's Taſte was pleaſant, but ſomething ſharp. So that Liquors may acquire a Sowerneſs, tho' no Spirits evaporate.

EXPERIMENT III.

Sept. 20.

Peaches and crude Grapes.

PEACHES and unripe Grapes, being included in two Receivers, in one of which was Apples bruis'd to a Pulp; In the other, an Infuſion of Raiſins of the Sun.

Sept. 25.

That in which the Raiſins were had, forced half it's Liquor out, and rais'd the Mercury 100 Inches, the Receiver being open'd, whilſt the Air got out, the Peach turn'd as ſoft as a Pultis; the Taſte of it was pleaſant. The other Receiver was unalter'd. Another Peach was ſhut up with an Infuſion of Raiſins of the Sun.

Sept. 26. The Mercury was 30 Digits higher than uſual. *Sept.* 27. It was 72. *Sept.* 28. It was 90. Liquor got out. *Sept.* 30. It was at a ſtand: the Liquor was all gone.

Octob. 1.

The Receiver was open'd, and the Peach tho' ſoft, taſted pleaſant.

Octob. 3.

The Receiver in which the Apples were contain'd being open, all things were much fermented; the Juice of the Apples having got out, the Peach tho' ſoft, taſted pleaſant.

Fruit cannot long be preſerv'd in the Pulp of Apples, they yield ſo much Air.

EX-

EXPERIMENT IV.

Sept. 23. 78.

PEACHES and crude Grapes being included in one Receiver with the Pulp of Apples, and in another with unripe Grapes bruis'd. *Pears with the Pulp of Apples.*

Octob. 1.

That which contain'd the Apples was unalter'd: But the other had loſt it's wind; one of the Peaches had loſt it's Firmneſs, both of them retain'd a grateful Taſte.

Feb. 5. 79.

That which contain'd the Apples, ſeem'd unalter'd; the Pulp and Peaches taſted grateful, but a little too pungent; when the Receiver was open'd, there happen'd a very great Ebullition.

EXPERIMENT V.

Sept. 25. 78.

TWO Butter Pears were ſhut up in a Receiver with Pulp of Apples. *Pears with the Pulp of Apples.*

Sept. 26.

The height of the Mercury was unalter'd.

Octob. 5	It was	16	*Octob.* 29.	It ſubſided.
6		16+	26.	The Receiver was crackt
12		16+		

One of the Pears began to rot, the reſt, as well as the Apples, taſted well.

EX-

EXPERIMENT VI.

Octob. 1. 78.

PEACHES being included with Pulp of Apples in one Receiver, and unripe Grapes bruis'd in another.

Octob. 5.

Wine got out. The Mercury was 64 Digits high. *Octob.* 6. Wine ran out. It was 70 Inches high. *Oct.* 8. All the Wine ran out: It was 86 high. *Oct.* 12. 86. *Oct.* 18. 86. The other Receiver which contain'd Pulp of Apples, for thoſe five Days, had loſt ſome Juice.

Decemb. 4.

The Receiver which contain'd the Apples being open'd, ſeveral Bubbles broke out, with a conſiderable Noiſe; The Peach was ſoft and pungent.

Jun. 28. 79.

The Mercury in the other Receiver, ſtay'd at the ſame height. The Peaches emitted ſeveral Bubbles, being wrinkled and a little alter'd in Colour; their Taſte was very pungent, and a little acid.

EXPERIMENT VII.

Octob. 4. 78.

Peaches with Wine and Beer.

PEACHES being ſhut in one Receiver with Wine; In another with Beer hopp'd; and in another with Beer without Hops.

Octob. 5.

The Mercury in the laſt was 15 Digits high. In the ſecond, 10. In the firſt, 9. *Octob.* 6. In the

the laſt. 25 Inches. In the ſecond, 15. In the firſt, 20. *Octob.* 8. In the laſt, 35. Second, 15. Firſt, 20.

Octob. 12.

In the laſt, 63. Second, 15. Firſt, 28. *Oct.* 15. In the laſt, 81. Second, 15. Firſt, 30. *Oct.* 16. No Alteration at all. 18. It deſcended a little in all. 22. The Aſcent in the Wine anſwer'd the Degrees of Heat and Cold. *Octob.* 24. In the laſt, it was 96 Digits high. Second, 15. Firſt, 30. *Oct.* 30. In the laſt, 115. Second, 29. Firſt, 30.

Nov. 3.

In the laſt, 117. Second, 20, Firſt, 30. *Oct.* 6. In the laſt, 120. Second 31. Firſt, 31. *Oct.* 11. In the laſt, 105. Second, 31. Firſt, 28. Cold Weather.

Nov. 16.

The Peach which was loweſt in the middle Receiver, roſe up to the Top; the others remain'd at the Bottom. *Nov.* 25. In the laſt, 140. The ſecond, 47. Firſt, 32. *Nov.* 28. In the laſt, 96. Second, 36. Firſt, 28. very cold Weather.

Decemb. 13.

In the laſt, 96. Second, 47. Firſt, 33. In the firſt, the Peach was firm, and well colour'd; it had borrow'd a Taſte from the Wine; which might be made grateful with Sugar. The Wine was very palatable.

Decemb. 30.

In the laſt, 96 Digits. Second, 47. The Peaches in the laſt when it was open'd, roſe up to the Top, and bubbled; The Taſte, which they had got from the Sugar, was made pleaſant with it.

Hence

Hence it appears, that fermented Liquors may preserve Fruit.

EXPERIMENT VIII.

Sept. 5. 78.

ONE Peach whole, and another cut, was included with old Wine in a Receiver.

Nov. 20. Some of the Wine ran out. *Nov.* 30. A third part was lost.

Decemb. 8. The Wine was almost lost, but what remain'd was pleasant; the Peaches were much fermented, and a grateful Taste.

This compar'd with the first Receiver in former Exp. shews, that Wine hinders Fermentation, if in a sufficient Quantity; but here the Peaches took up too much Room.

EXPERIMENT IX.

Octob. 11. 78.

A Whole Peach, and another cut, was included in hopp'd and fermented Beer.

Octob.	12		3	*Nov.*	8		31
	15		15		11		48
	16		15		12		46
	18		12 very cold.			It was	Beer got out.
	20	It was	12		16		46
	22		12 x Warmer.		19		43 Beer lost.
Nov.	2		20		20		Beer lost.
	3		Lower, cold.		23		It was almost all
	6		23 hotter.				lost. The Receiver being open'd, the Peaches were soft, yet of a grateful Taste.

This

This Exper. compar'd with the ſecond Receiver, *Exp.* VII. ſhew that Beer in a ſufficient Quantity, hinders the Generation of Air, and Fermentation of Peaches, but here the Peaches took up too much Room.

EXPERIMENT X.

Octob. 19. 78.

RAW Beef being ſhut up with ſtale Beer, compreſs'd till the Mercury roſe 60 Digits above it's uſual height. In another it was ſhut up with Beer uncompreſs'd: And in a third, the Receiver was fill'd with common Air. *Beef with ſtale Beer.*

Octob. 20. In the firſt it ſunk 40 Digits. In the ſecond, a little. In the third, it aſcended a little.

Octob. 26. In the firſt, it aſcended and deſcended irregularly: It aſcended ſlowly in the ſecond. In the third it was at a ſtand.

Oct. 27. A Piece left in the Air, began to ſmell ill: In the ſecond and third, the Mercury aſcended: In the firſt it deſcended.

Nov. 3. In the ſecond, it was 20; in the third, 10 Digits high.

Nov. 5. The two firſt did not ſtink, but the Fleſh had got a Taſte from it; and being boil'd in it, was tender. That included with common Air, ſtunk. But the ſame piece of Beef being ſhut up again with Air. *Nov.* 6. Mercury was rais'd 3 Digits. *Nov.* 11. 8. *Nov.* 25. 20 Digits. The Fleſh ſtunk.

Hence it appears, that Beer may preſerve Beef, when compreſs'd for ſome time.

EX-

EXPERIMENT XI.

Nov. 12.

Beef with Water and Salt.

BEEF was ſhut up with Water, and a fortieth Part of Salt, in one Receiver; In another with Salt Water, compreſs'd till the Mercury was rais'd 15 Digits above it's uſual height. In a third, Fleſh and Air was only enclos'd.

Nov. 13. Mercury deſcended in all; eſpecially where the compreſs'd Water was.

Nov. 18. In that which contain'd compreſs'd Water, it almoſt roſe to it's former height. A piece of the ſame Beef expos'd to the Air, began to ſmell ill.

Nov. 23. Air was generated in all; The Mercury in the ſecond was 20 Digits, having deſcended 3. In the other two, it was about 16. In the firſt the Fleſh was not corrupted.

Nov. 30. The Fleſh included with Salt, did not ſtink; but when boil'd, was tender and pleaſant.

Decemb. 6. The Mercury in that which contain'd the compreſs'd Air was 25 Digits: The Fleſh was ſtrong ſcented, but did not ſtink. That included in *Vacuo*, bubbled when the Receiver was open'd, and in an hours time yielded Air enough to ſuſtain 3 or 4 Digits of Mercury. The Receiver which contain'd it, being immers'd in hot Water, the Liquor bubbled much, tho' the Water it was immers'd in, did not boil; the Receiver was ſoon full of Air, and then, tho' it was immers'd in boiling Water, the Liquor did not bubble. The Fleſh was plea-

pleaſant and tender. So that Water as well as Beer may help to preſerve Fleſh.

EXPERIMENT. XII.

Nov. 29. 78.

OYſters were ſhut in one Receiver without their Shells; In another they were ſhut up in their Shells with common Air, and in a Third with Salt-water. Theſe three being cloſed up with Screws, 3 Oyſters in their Shells, and 8 taken out were ſhut up *in Vacuo*; where it was obſervable, that when the Air was exhauſted, thoſe which were without their Shells emitted large Bubbles, one of the others opened the Shell. *Oyſters.*

Nov. 30.

The Mercury in *Vacuo* aſcended a little, but in thoſe 3 which were ſtopped with Screws it deſcended rather.

Decemb. 4.

The Weather growing warmer, the Mercury in the firſt Receiver was 7 Digits. In the Second, 0. In the Third, 3. In the Fourth 3.

Dec. 5. In the Firſt 20. In the Second, 1. In the Third 3. In the Fourth 5.

Dec. 7. In the Firſt the Height of the Mercury was 30. In the Second 1 Digit. In the Third 3. In the Fourth 8. Other Oyſters left in the open Air began to Smell ill.

Dec. 9. In the Firſt it was 30; In the Fourth 11. In the Reſt no Change.

Dec. 13. In the Fourth it was 14 Inches High.

Dec. 20. In the Firſt it was 46. In the Fourth 24. No alteration in the others.

Dec. 21. In the *1ſt.* 52. In the *4th.* 25. No alteration in the others.

Dec. 22. In the *1ſt.* 60. In *4th.* 27. No alteration in the Reſt.

Dec. 27. In the *4th.* 29. No alteration in the Reſt.

Jan. 7. 79.

The Oyſters in the Third Receiver had Coloured the Water black.

Jan. 25.

Some Bubbles were formed in the Turpentine, about the Commiſſure of the Receiver and Cover, of that which was exhauſted; the Height of the Mercury was not altered, but the Oyſters being taken out Stunk: Thoſe in the other Receivers Stunk, and were turned to a viſcous Gelly.

From this Experiment it ſeems to follow, that Fiſhes yeild not ſo much Air as Fleſh; yet they will Corrupt tho' not affected by the outward Air.

EXPERIMENT XIII.

Nov. 29. 78.

A Veſſel of freſh Butter.

A Glaſs Veſſel filled with freſh Butter, being conveyed into a Receiver with a Mercurial Gage.

Nov. 30.

The Butter being in the Night condens'd by Cold, the Mercury ſunk a little.

Dec. 2.

Decemb. 2.

The Cold encreaſing, the Mercury ſunk ſenſibly.

Decemb. 5.

The Cold growing more remiſs, the Mercury aſcended almoſt to its former Height; ſome of the ſame Butter having been all the time expoſed to the Air, ſmelled ill.

Decemb. 7.

The Cold coming on again, the Mercury returned to the Top of the Gage. The Butter in the open Air ſmelled worſe.

Decemb. 24.

The Butter had yeilded no Air, but was all of a gratefull Taſte, except the Superficies of it, which was contiguous to the Leather. So That Butter may be Preſerved a long time, if Preſerved from the Contact of Air.

EXPERIMENT XIV.

Nov. 30. 78.

ONE Receiver was filled with Whitings and Wine, another with Whitings and Oyſters. When the Screws were Set, the Mercury in the Gage was compreſſed, but in 3 hours returned to it's former Mark. *Whitings and Oyſters.*

Decemb. 2.

The Cold increaſing, the Mercury Sunk in both.

Decemb. 4.

The Cold ceaſed, and the Mercury aſcended in that Receiver which contained the Oyſters.

Decemb. 5.

In that which held the Oyſters, the Mercury was Raiſed 20 Digits.

Decemb. 7.

It roſe to 40 Digits. *Dec.* 9. No alteration in either; that in which the Wine was contained, remaining ſtill below it's firſt Height.

Decemb. 20.

The Contents of both ſtunk. But what was remarkable in this Experiment, was, that there was Corruption without a Generation of Air, in that Receiver which contained the Wine.

EXPEREMENT XV.

Decemb. 3. 78.

Raw Beef with Pepper and Cloves.

RAw Beef with Pepper and Cloves being put into two Large Receivers, and as much Beer added as filled the Remaining ſpace, in a little time after the Preſſure of the Air growing more Remiſs, the Mercury came almoſt to the open ends of the Gage.

Decemb. 8.

The Mercury aſcended not. The Beef being taken out of one to be Boil'd, had acquired a ſweet ſmell from the Cloves, and the Liquor ſmelt like Hippocras.

Jan. 2. 79.

The other Receiver was opened, no Air being produc'd. The Fleſh was uncorrupted; and being Boil'd in *Vacuo* with an intenſe Fire, I obſerv'd, Air or Spirits broke out at the Stop-cock faſtned to the Top of the Receiver. When the Receiver was Cool the next day, it was almoſt void

void of Air; The Fleſh was Tender, and well Taſted, only it was Boil'd a little too much, having been on the Fire Six Hours.

Hence it appears, that Beer impregnated with Aromaticks will preſerve Fleſh.

EXPERIMENT XVI.

Decemb. 4. 78.

TWo Larks with ſome Beef being ſhut up in a Receiver, with as much Ale as filled up the Space not poſſeſſed by them: Another was filled with Beef alone, and a Mixture of Beer and Ale. *Larks with Beef.*

Decemb. 9.

Some Pieces of the Larks which were expoſed to the Air, began to ſmell ill; but thoſe in the Receiver had not yeilded Air enough to ſuſtain 5 Digits of Mercury. In the other Receiver no Air was Generated.

Decemb. 19.

The Cover of the Receiver, which held the Larks being broke, Liquor ran out: The Beef and Larks were uncorrupt, and being Boil'd Taſted gratefully, the Taſte of the Beef being made pleaſant by the Mixture of the Larks and Beer.

Decemb. 23.

The other Receiver being opened, the Boil'd Fleſh ſeem'd pleaſant. Hence it appears, that Birds may be preſerved long in Beer and Ale.

EXPERIMENT XVII.

Decemb. 14.

Apples and Sugar, &c. ONe Receiver was filled with a whole Apple, and a ſufficient quantity of Powdered Sugar. A Second was filled with an Apple cut in Pieces, and Sugar. A Third was filled with an Apple cut in Pieces and Water, with a $\frac{1}{18}$ part of Sugar. A Fourth had 5 parts of Water, and one of Sugar included with an Apple cut in Pieces.

Decemb. 21.

In the firſt the Sugar was not Melted; The Mercury aſcended a little. In the Second the Sugar was Melted and the Apples ſhrivel'd; they yeilded much Air when Firſt included in the Receiver. In the other Two the Mercury aſcended a little. In the Third the pieces of Apple were corrupted very much, for the Skin was taken off.

Decemb. 22.

Air was produced in all the Receivers, but moſt in the Second and Third.

Decemb. 27.

In the 3 Firſt the Mercury was 10 Digits high, in the Fourth 6.

Decemb. 31.

In the 1*ſt.* and 2*d.* It was 13. In the 3*d.* 15. In the 4*th.* 9.

Jan. 2. 79. In the 1*ſt.* and 2*d.* almoſt 14. In the 3*d.* 17. In the 4*th.* 11.

Jan. 7. In the 2*d.* It was 16. In the 3*d.* 36. In the

the Fourth 15. The Mercury in the Firſt roſe no higher; but the Air made it's eſcape, when the Screw was eaſed.

Jan. 9. In the firſt it was 6 Inches high. In the 2*d.* 16. In the 3*d.* 39. In the Fourth 15.

Jan. 17. In the 1*ſt.* 13. In the 2*d.* 19. In the 3*d.* 56. In the 4*th.* 17.

Jan. 30.

In the 3*d.* 76. Digits. The Liquor broke out, and therefore I opened the Receiver. The Fruit had communicated it's Taſte, which was pleaſant, to the Water; The Mercury in the 2*d.* being raiſed no higher, I opened it, and found that the firſt was better Taſted than the former, and having communicated, in a great Meaſure, it's Taſte to the ambient Sugar, It was in the form of a good Syrup.

Feb. 16.

The Mercury in the Firſt Receiver was 22. In the Fourth 33. The Receiver being opened, I found that the Taſte of the Firſt being wholly imparted to the Water, had made it very Pleaſant.

Feb. 27.

The Mercury in the Firſt Receiver was 30 Digits high.

March 15.

The Receiver being opened, I found, that tho' the Colour of the Apple was good; yet the Pulp was Spungy, and had in a great Meaſure loſt it's Taſte.

Hence it appears, that Sugar does not preſerve Fruit ſo well as Fermented Liquors. See *EXP.* VII.

EXPERIMENT XVIII.

Decemb. 23.

Milk included in a Receiver.

A Glaſs Veſſel being full of Milk, and ſtopped with a Screw, was conveighed into one Receiver, and Milk with a Lark in it into another.

Decemb. 24.

In the Evening the Caſeous and Butyrous Parts were ſeparated both in the Milk in the Receivers, and in ſome of the ſame expoſed to the Air.

Decemb. 27.

No Air generated where the Lark was; The other Gage was ſpoiled.

Decemb. 31.

The Mercury was raiſed in that which held the Lark. 5 days ſince, Milk that had all the while been expoſed to the Air, Stunk.

Jan. 1. 79.

The Mercury was 10 Inches high, where the Lark was contained.

Jan. 2. It was 14½. The Milk below the Butyrous Part ſeemed red.

Jan. 4. It roſe to 19 Digits. White Serum grew together in the Bottom of the Milk.

Jan. 9. The Mercury was 29 Digits high.

Jan. 25. The Receivers being opened, the Lark Smelled ſtrong, but when Boil'd Taſted Pleaſant; tho' it had been kept 32 Days. In the other Receiver the Butyrous part was ſowre, but the Caſeous Part Taſted ſubacid.

From hence it appears that Milk may Preſerve Fleſh.

EXPERIMENT XIX.

Decemb. 24. 78.

A Lark was put into a Small Receiver, and the Remaining ſpace filled up with Melted Butter. *A Lark with Melted Butter.*

Decemb. 27.

The Mercury ſunk, the Butter grew Yellow below, White in the Middle, and Fluid above.

Jan. 5. 79.

The Mercury gradually roſe.

9. It was a little higher.

28. It was altered but little, the Receiver being opened; the Butter contiguous to the Leather which Lined the Cover, was of an ungrateful Taſte and white. The Reſt of the Butter was Yellow and Rancid. The Lark being Roaſted was Pleaſant to the Palate. Hence it appears, that Butter when Melted and hot, does not preſerve Fleſh ſo well as otherwiſe.

EXPERIMENT XX.

Jan. 4. 79.

A Receiver being filled with Boil'd Fleſh and Broth, whilſt the Screw was Set, they were ſo Compreſſed as to Raiſe the Mercury 6 Digits, but it ſoon ſubſided again. *Boiled Fleſh and Broth.*

Jan. 28.

Jan. 28.

The Mercury had ſubſided 8 Digits below it's uſual Height. The Receiver being opened, we found the Fleſh Sweet and Pleaſant; The Broth Subacid and well Taſted.

This Experiment Teaches, that Beef being kept in Receivers as long as Experience ſhews that it may, and then taken out and Boil'd, and included again in Receivers, may be carried to Sea without Salting it, which may be of no ſmall uſe in helping to preſerve Beef Freſh in long Voyages. See. *EXP.* XII.

EXPERIMENT XXI.

Jan. 30. 79.

Raw Fleſh with Pepper and Cloves.

RAw Fleſh was included with Pepper and Cloves in one Receiver, and in another by it ſelf.

Feb. 11.

In the Firſt the Mercury was 3 Digits high. In the Second almoſt 1½.

Feb. 12. In the Firſt 4½. In the Second 1½.

Feb. 13. In the Firſt 6+. In the Second 3.

The Fleſh of the Firſt being boiled was Tender and Pleaſant.

Feb. 14 In the Second 5

19 In the Second 6

20 In the Second 11. The Fleſh being Boil'd was Tender and good, tho' it was kept in B. *Mariæ* but 5 hours. Some of it before it was boil'd was put into a Receiver free from Air.

Feb. 28.

Feb. 28.

The Aſcent of the Mercury was ſmall.

March. 20.

The Mercury was 16 Digits high. The Fleſh being taken out Taſted Pleaſant, but was inclining to corruption.

EXPERIMENT XXII.

Feb. 10.

RAw Beef Seaſoned with Pepper and Cloves was put into one Receiver. In another it was encloſed with Salt. In a Third alone.

Feb. 19.

In the 1*ſt.* and 3*d.* the Mercury aſcended. In the 2*d.* it did not.

Feb. 21.

In the 1*ſt.* it was 4½ : In the 3d. 10 : In the 2*d.* 0.

25 In the 1*ſt.* it was 6 : In the 3*d.* 19 : In the 2*d* ½ :

26. No Aſcent : The Third being opened, and the Fleſh Boil'd, it taſted well. In the former Experiment Spices ſeem'd to hinder, but here they promote the Generation of the Air : So that I am inclined to think, that the difference in theſe two Experiments depends on this, *Viz.* that in the former the Ingredients were ſhut up ſo cloſe that there was no Room for Air to be Generated in.

March 9.

The Mercury in the 1*ſt.* was 8 Digits ; In the 2*d.* None.

12. In the 1*ſt.* it was 12 ; In the 2*d.* 1.

April 3.

April 3.

In the 1*st* it was 11 : In the 2*d* 1.

April 3.

In the 1*st* it was 11 ; In the 2*d* 1.

The Receiver being open'd and the Flesh boil'd, it was sweet and tender.

From this Experiment we may infer, that Salt hinders the Generation of Air. Less Air was generated in the second Receiver, because it was more exactly fill'd. To preserve Flesh without Salt the Air must be kept out; and likewise there must be a great compression in the Receiver.

Of what use these Experiments may be for to help Mariners to transport fresh Meat and Fruits, the Reader may judge.

ARTICLE XVIII.

Experiments concerning Elixation and Distillation in Vacuo.

EXPERIMENT I.

Dec. 12. 78.

Beef boil'd in Vacuo.

A Reciver large enough to contain 22 Ounces of Water, having 2 Ounces and 6 Drachms of Beef in it, was immers'd 3 hours in boiling Water, and then left to cool all Night;

Night; I found by the help of our Pneumatick Engin that the Air form'd in the Receiver, was not able to hold up 3 Digits of Mercury: So that by deducting from the Calculation, one may learn that Fleſh, whilſt boiling, cannot generate a ſufficient Quantity of Air to cauſe an entire preſſure in a Receiver large enough to hold a double Weight of Water: That is, a Pound of Fleſh ſhut up in a Receiver capable of containing 2 Ounces of Water, will not yield Air enough to ſever the Receiver from the Cover without the help of heat.

EXPERIMENT II.

Dec. 23.

THree Ounces of Beef being ſhut up in a Receiver large enough to contain 32 Ounces of Water, when it had boil'd long, ſeparated the Receiver from the Cover, ſo that Vapours got out. The Receiver being cloſe again, it was a good while before the Cover and it were ſever'd a ſecond time: If the Fire be ſtrong enough, ſweet Exhalations continually make their way out.

Dec. 24.

The Receiver being cool, was almoſt wholly evacuated by the Pneumatick Engin: So that it appears, that the Receiver and it's Cover are not ſeparated by Air which is able to continue in that Form; but by violent exhalations, which when reſiſted, fall back, and condenſe in the Re-

Receiver, ſo that if the Fire be not too violent, the Avolition of thoſe Steams may eaſily be prevented.

EXPERIMENT III.

Jan. 21. 79.

Paſte without Leaven in Vacuo.

PAſte without Leaven being ſhut up in *Vacuo* and in another Receiver with Common Air: And both of theſe ſhut up with a Screw in *Balneo Mariæ*, I left them there 3 hours, and then after they had been expos'd to a moderate Fire, I caus'd them to be open'd. The Paſte in *Vacuo* was reddiſh on it's Superficies, the other was not boil'd enough, therefore both were ſhut up in *B. M.* all Night.

Jan. 22.

The Paſte being taken out, was ſufficiently boil'd, but had no Cruſt. That in *Vacuo*, was full of Cavities and inſipid; the other was well Taſted and of a Cloſe Body. Both Receivers were void of Air.

EXPERIMENT IV.

Feb. 3. 79.

WHen Leaven'd Paſte had fill'd a Receiver full of Air, it was remov'd into another, upon which it ſtunk; yet when it was in a hot *Balneo M.* 3 hours, Bread was made of it full of holes, but without a Cruſt.

Feb.

Feb. 5.

The ſame Experiment being repeated without removing the Paſte from one Receiver to another and expoſing it to the Air, the Bread made of it was much lighter than the Former.

EXPERIMENT V.

Feb. 12.

Roſemary and Water diſtill'd in Vacuo.

ROſemary and Water being ſhut up in the Inſtrument, contriv'd to diſtil in *Vacuo*, that being plac'd in *Balneo Mariæ*, it yielded a Water which had a ſweet Smell; as alſo ſome Drops of eſſential Oyl, well ſcented and clear from any *Empyreuma*. But the Stop-cock being open'd to let in Air, the Noiſe which the Air ruſhing in caus'd, was ſoon over, ſo that I judge the Roſemary had afforded a good deal of Air.

Feb. 13.

The ſame Roſemary being again expos'd to a more violent Fire, it only yielded a Water leſs odoriferous than the former.

EXPERIMENT VI.

Feb. 10. 79.

Fleſh boil'd in Vacuo.

A Pound of Fleſh was boil'd in *Vacuo*, with 4 pound of Water, and in 3 hours the Mercury, in a Gage which was contain'd in the upper Part of it, was not rais'd above 3 Inches. It Taſted ill, as alſo the Liquor which was made

of the condens'd Vapours; it was not boil'd enough.

Feb. 11.

The ſame Experiment was repeated, the Fleſh being firſt ſprinkled with Pepper and Cloves, the Mercury aſcended 6 Inches, in the ſame time that before it was rais'd 3: It Taſted well, and the Liquor form'd of the Vapors Taſted ſtrong of Pepper.

Theſe Veſſels ſeem proper to diſtil Bodies that are very thin and Volatile in.

ARTICLE XIX.

Concerning Elixation in Veſſels ſtopp'd with Screws, by whoſe help, Harts-horn and the Bones of Fiſhes and four-footed Creatures may be ſoften'd.

EXPERIMENT I.

Jan. 29.

Beef boil'd in B. M.

BEef boil'd in *Balneo Mariæ* eight or nine hours, in a Veſſel ſtopp'd with a Screw, had a very unpleaſant Taſte: After I boil'd Beef ſeaſon'd with Pepper and Cloves 3 hours and it Taſted very pleaſant: Beef that was not ſo Seaſon'd being boil'd 3 hours Taſted well. So that I conjectur'd that the firſt Fleſh was ſpoil'd with over-boiling, when the Fleſh was not

not ſeaſon'd, Vapours gather'd in the Top of the Veſſel, and condens'd Taſted unpleaſant.

EXPERIMENT II.

Jan. 29.

APples boil'd 2 hours, were ſoft and well Taſted; but ſome Pieces, impregnated with the condens'd Vapours, which were of an ungrateful Smell, had acquired a leſs acceptable Taſte.

EXPERIMENT III.

Feb. 4.

Seaſon'd Fleſh inclos'd in a Receiver.

FLeſh cloſely compreſs'd and ſeaſon'd with Pepper and Cloves, being ſhut up in a Receiver ſtopp'd with a Screw, that was kept hot in *Balneo* an hour, in which time the Fleſh was alittle over boil'd: when the *Balneum* was open'd, all the Water broke out.

Feb. 5.

Some Part of the Water was inclos'd in a Receiver ſhut up with a Screw.

March 12.

The Fleſh was very good. Elixation, by how much the more perfect, contributes the more to the hindrance of Fermentation. *See Art.* XVIII. *Exp.* XII, XX.

EXPERIMENT IV.

Feb. 10.

Cow-heel boil'd in Vacuo.

A Cow-heel being boil'd, four hours over a moderate Fire, was ſo ſoft, that the Bones might be eat like Cheeſe.

Feb. 12.

A Cow-heel being boil'd 12 hours, Taſted Empyreumatical, and the Juice would not Coagulate: So that hard Bones and Tendons in *Balneo Mariæ* may become good Nouriſhment.

EXPERIMENT V.

Feb. 10.

A Fiſh boil'd in *B. M.* 2 hours Taſted well, and the Bones were very ſoft. The Juice harden'd preſently into a Gelly of a firm Conſiſtence. This is a good way to boil Fiſh that are full of Bones.

EXPERIMENT VI.

Feb. 5.

Harts-horn boil'd in Vacuo.

HArts-horn boil'd 4 hours, was very ſoft like Cheeſe, and the Juice preſently harden'd into a Gelly.

Feb.

Feb. 17.

The Experiment being repeated, the Hartshorn was Boil'd 6 hours, and grew very ſoft: The Juice getting out of it, harden'd into a Gelly, and ſtuck to the outſide of it.

Theſe Experiments may be of great Uſe to Mariners, ſince by them they may learn how to boil their Meat with out conſuming freſh Water, which may be kept for other more cogent Occaſions.

CHAP. IV.

New Experiments about the Preſervation of Bodies in Vacuo Boyliano.

EXPERIMENT I.

Several Subſtances included in Vacuo.

A Piece of roaſted Rabbet was preſerv'd in *Vacuo* above two Months unalter'd.

EXPERIMENT II.

WHite Bread being enclos'd in *Vacuo* from the 11*th* of *March* to the 1*ſt* of *April*, was unalter'd, ſave that the outſide of ſome Crumbs were a little dry; nor was it any further alter'd in 17 days time more. The inſide of the Receiver was not Moiſt.

EXPERIMENT III.

Milk having been ſhut up in *Vacuo* three Months, ſmell'd and Taſted ſowriſh, being turn'd partly into a Whey, and in Part into a ſoft Curd.

EXPERIMENT IV.

Violet Leaves being ſhut up a Month and 2 days in *Vacuo*, had undergone no Alteration, but that they had loſt their ſmell by being cruſh'd down into the Veſſel; it being uſual for them by cruſhing to exchange their Fragrancy for an earthy Smell.

EXPERIMENT V.

SOme Violets being kept 7 Months in *Vacuo*, ſome retain'd their proper Colour, others look'd like white Violets.

EXPERIMENT VI.

SHeeps Blood being ſhut up in *Vacuo*, whilſt the Receiver was exhauſting emitted Bubbles and ſwell'd: Being kept in a heat equal to the heat of a digeſting Furnace, for two days, was Florid and Fluid; afterward it inclin'd to a Blackneſs: Eighteen days after, external Air ruſhing in, and the Glaſs which held the Blood, being in a light Place; we perceiv'd the lower ſide of it to be cover'd with a Coagulated ſubſtance of a deeper Colour than that which

which ſwam upon it; but when, by ſhaking, it was rais'd, it ſeem'd of a fair Colour: The Blood being pour'd out, had no more an offenſive Smell than the Blood of a newly kill'd Dog.

EXPERIMENT VII.

CReam being ſhut up in *Vacuo* near a Year, was like Butter on the top, which by agitation was ſeparated from the Butter-Milk it ſwam in: The Butter-Milk was of a grateful Sowerneſs, like other Butter-Milk; but the Butter was Sowrer.

EXPERIMENT VIII.

SOme ſlices of roaſted Beef being put into one Vial; White Bread into another; and pieces of Cheeſe into a third, on the 15 of *September*; *February* the 18 we perceived little Alteration; they being free from Putrefaction.

EXPERIMENT IX.

July-Flowers and a Roſe being inclos'd in a Vial on the 12*th* of *Auguſt*; *February* 18 they were a little moiſt; but retain'd their Shape and Colour. In theſe two Experiments no Dew was perceiv'd in the upper Parts of the Receiver.

EXPERIMENT X.

STrawberries being included in *Vacuo*, *June* the 4*th*: In the beginning of *November* we found them alter'd in Colour, but not in Shape. No ſign of Corruption appear'd.

EXPERIMENT XI.

ROaſted Beef, Cheeſe and a *French* Roſe being included in three diſtinct Receivers in *Vacuo*, *May* the 2*d*; were unalter'd *September* the 5*th*: Flowers were preſerv'd unalter'd 8 Months and a half.

EXPERIMENT XII.

A Pint of Beer, which was a Year Old, being ſhut up in *Vacuo*, *June* 17; tho' in *Auguſt* Thunder turn'd the Drink in our Cellar ſower; yet that in *Vacuo* appear'd unalter'd *September* 1.

EXPERIMENT XIII.

ALe being inclos'd ſix Weeks in *Vacuo*; tho' Thunder happen'd which turn'd the Ale in the Cellar Sower, yet this was good as before.

E X-

EXPERIMENT XIV.

BLackberries included in *Vacuo September* 1*ſt*, 70; *June* 20*th* 73 were free from an ill Scent, and not in the leaſt Mouldy; ſome ſower Liquor being taken out from under them, they were ſhut up again.

Octob. 11. 74.

They were much blacker than before: No other perceivable Alteration. It is not a little ſtrange, that ſo tender a Fruit ſhould thus be preſerv'd ſo long.

POSSCRIPT.

TO ſhew that Liquors, by being Hermetically ſeal'd in Bolt-heads, may be kept from ſowering a long time, *June* 14 we ſhut up good Ale in one; the 5*th* of *July* next Year after, it was not ſower: In 13 Months time after it was turn'd a little Sower. This Ale was preſerv'd much longer from ſowering than otherwiſe it would.

June 14. 70.

A Pint of *French* Claret being ſhut up, *July* 5, 71 was clear and high Colour'd, and had depoſited a Sediment. When the Glaſs was broken, white Streams roſe plentifully from the Wine, which preſently diſappear'd again: The Wine was rough, but well Taſted.

July 6.

It was shut up again. *August* 5, next Year the Wine Tasted well. *June* 20, 73, it was still good, and therefore Seal'd up again.

Octob. 11. 74.

It was open'd again; and appear'd to be well Colour'd, but less Spirituous; yet it was not Sower.

CHAP. V.

New Pneumatical Experiments about Respiration, upon Ducks, Vipers, Frogs, &c. communicated in the Philosophical Transactions of August *the* 8th *and* September *the* 12th 1670. *contain'd under the following Titles.*

TITLE I.

Observations made about the lasting of Ducks included in the exhaust'd Receiver.

EXPERIMENT I.

Animals shut up in Vacuo.

TO try whether Ducks, which continue a good while under Water without Respiration, would bear the absence of Air much longer, than other Animals in *Vacuo*, we inclos'd a Duck in a Receiver, which a was third Part fill'd by her: The Air being exhausted

she

ſhe continu'd well longer than a Hen would have done; yet in a Minute ſhe was diſcompos'd; and in two, ſhe, after violent Convulſions, hung down her Head as if dead, but preſently reviv'd when Air was let in. Being ſhut up much longer in Common Air, ſhe was not Diſcompos'd.

EXPERIMENT II.

A Callow Duckling being ſhut up in a Receiver, in a Minute ſeem'd diſorder'd: In leſs than two Minutes being ready to dye and violently Convulſive, we let in Air; upon which ſhe recover'd. Being ſhut up 6 Minutes with Common Air, ſhe ſeem'd well. *N. B.* The Duckling ſeem'd much bigger when the Air was exhauſted, than before. *A Duck.*

TITLE II.

Of the Phenomena *afforded by Vipers, included in an exhauſted Receiver.*

EXPERIMENT I.

TO try what effects Air would have upon Vipers, (Animals conſtituted differently from other Creatures) *January* 2, 6¾ A Viper was ſhut up in a Receiver; as the Air was drawn out ſhe began to ſwell, and ſoon after we ceas'd Pumping, ſhe began to Gape. In 2¼ hours ſhe did not appear to be quite Dead: Soon after ſhe *A Viper.*

ſhe gap'd, the ſwelling ſubſided, but preſently roſe again.

EXPERIMENT II.

ANother Viper being ſhut up in *Vacuo*, after ſhe had mov'd a little up and down, began to froth at the Mouth; ſoon after we left pumping, her Body and Neck ſwell'd prodigiouſly, and a Bliſter roſe on her Back, 1½ hour ſhe appear'd to be alive, but no longer. Her Neck and a great part of her Throat ſeem'd tranſparent; Her Mouth was open and diſtorted; The *Epiglottis* with the *Rimula Laryngis* was almoſt thruſt to the end of the Neather Chap. The black Tongue ariſing from beneath the *Epiglottis*, raught beyond it, but ſeem'd dead. The Mouth was black within. Upon a Re-admiſſion of Air, in 23 hours, the Mouth was ſhut, tho' it open'd again. Scorching or pinching the Tail caus'd Motion in the Body of it.

EXPERIMENT III.

A Snake. A Snake, being incloſ'd 22 hours with a Gage in a Receiver, ſeem'd dead; but when held ſomething near the Fire, put out her forked Tongue. The next day ſhe was dead, her Jaws gaping as if ſtretch'd with Violence.

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TITLE III.

Phænomena *afforded by Frogs in an exhauſt-Receiver.*

EXPERIMENT I.

Sept. 9. 1662.

A Large Frog being ſhut up in *Vacuo*, was but little ſwell'd, and mov'd her Throat almoſt as faſt as before the Receiver was evacuated. Her Body ſwell'd more, and ſhe continu'd alive about 2 hours. In a little more than 3 hours ſhe ſeem'd dead; but being left all night upon the Graſs, ſhe recover'd again. *Frogs in Vacuo.*

EXPERIMENT II.

A Frog being enclos'd in a Receiver almoſt totally exhauſted, about 11 a Clock; at the firſt ſeem'd unalter'd, but in ſix hours dy'd.

EXPERIMENT III.

Sept. 6. 62.

A Slender and a large Frog being both included in a Receiver; whilſt it was exhauſting, the Leſſer skipp'd up and down, and ſome time after; but in a quarter of an hour ſeem'd dead. The Larger Frog ſwell'd a little, and continued alive half an hour; but the Receiver leaking, we purſu'd the Experiment no further.

EX-

EXPERIMENT IV.

A Small Frog being included in a Receiver, at the first seem'd lively; but after, mov'd up and down as if very uneasie; yet was alive when the Receiver was wholly exhausted for the Space of an hour, but at the latter end of the time, she wanted Respiration, and her Belly and Throat were swell'd. In 3½ hours time, the Air being let in, the *Abdomen* and Throat subsided, and instead of a Swelling, there remain'd a Cavity.

EXPERIMENT V.

A Large Frog being shut up in a plated Receiver exhausted, in seven hours was dead, being much swell'd; but upon an Ingress of Air, was lanker than ever.

TITLE IV.

Of the Phænomena *afforded by a newly kitten'd Kitling in* Vacuo.

A Kitling in Vacuo.

A Newly kitten'd Kitling being included in a Receiver, when it began to be exhausted, in a Minute, after Convulsions, lay with the Tongue out as if dead; but when expos'd to the Air, in a Trice recover'd. Another Kitling of the same Age, being included in the same Receiver, after it had been, by turns, convulsive six Minutes, upon pumping out the Air, seem'd dead; and when taken out of the Receiver, lay with its Tongue out, without either

Pulse

Pulſe or Reſpiration; but being pinch'd, it preſently gave ſigns of Life, and in a quarter of an hour, gaping and ſtraining to fetch Breath, it recover'd. A third being put into the ſame Receiver, after violent Convulſions and want of Breath, in a Minute and half ſeem'd dead, no more Air being drawn out, than what was done at 3 Exſuctions. The Pump being ſtill ply'd, and the Kitling ſeeming to ſwell, ſome time after gave ſigns of Life, being violently convuls'd. After it had been incloſ'd 7 Minutes, we let in the Air, and put *Aq. Vitæ* into the Mouth of the Kitling, yet it dy'd in our Hands. Theſe Animals continu'd perhaps 3 times as long alive in *Vacuo*, as others would have done.

TITLE V.

Some Tryals about the Air, uſually harbour'd in the Pores of VVater, &c.

TO try how much Air is contain'd in a Quantity of Water, in reference to their Bulk: We fill'd a Chymical Pipe 36 Inches long, with Water, and inverted it in a Glaſs Veſſel about ½ of an Inch deep, and 2 Inches Diameter. Theſe being included in a Receiver, the Air was pump'd out, and upon a Re-admiſſion of it, the Bubble collected at the Top, wanted $\frac{1}{10}$ of about 100 part of an Inch. Soon after, a Tube, to be deſcrib'd by and by, was fill'd with the ſame Water, and inverted; and when the Receiver, into which it was conveigh'd, was ſo far exhauſted, that the Water in the Pipe ſunk,

Air conceal'd in the Pores of Water.

ſunk even with the ſtagnant Water, Air was let in, and roſe the Water within a Tenth part and ¼ of an Inch to the Top. The Tube was 43¾ Inches above the ſtagnant Water; this Experiment being twice try'd, the firſt time the Space poſſeſs'd by the Air was ¼ of an Inch, and more; the ſecond it was ⅓ and $\frac{1}{16}$. The firſt time the Water ſubſided level with the ſtagnant Water: In the ſecond Tryal, within 4 or 5 Inches of it.

In theſe Experiments it was obſervable, that tho' the Air poſſeſs'd ſo little Room in the Pores of the Water, that the Water ſeem'd not to ſubſide when it was drawn out; yet, the Air in the Cavity of the Tube, poſſeſs'd a conſiderable Space.

Quære. Whether Water freed once of it's Air, will yield Air again? and whether there is not Air enough in the Pores of Water, to be ſerviceable to Fiſhes, when ſuck'd through their Gills?

To diſcover more nicely what Quantity of Air is contain'd in the Pores of Water, we made uſe of a Pipe, which conſiſted of a Globous Part 3½ Inches Diameter, and a Stem 9 Inches long; an Inch of which, at the Top, was melted and drawn out 2 or 3 Inches, till it was as ſlender as a Crow Quill: This Glaſs being fill'd with Water, was with a Pedeſtal conveigh'd into a Receiver, and upon evacuating of it, Bubbles plentifully roſe, and made a kind of a Froth or Foam, but breaking at the Top of the ſlender Pipe, they did not run over. When the Receiver had been pretty well exhauſted, we left off pumping till the Water had been pretty well freed,

freed from Bubbles; and ſo we ſucceſſively pump'd and left off again, till the Water ſeem'd quite free from Air; and then, letting in External Air, the Water did not ſeem a Hairs breadth lower than before. The like Experiment was try'd with Claret, which made us think it worth while to try what kind of Subſtances may be obtain'd from Aerial and Spirituous Bodies, by handling them thus.

TITLE VI.

Of ſome Phænomena, *afforded by Shell-Fiſhes in an exhauſted Receiver.*

EXPERIMENT I.

TWO Oyſters in their Shells, being ſhut up in *Vacuo*; whilſt the Receiver was exhauſting, ſeveral Bubbles got out of the Shell; the Oyſters were alive at the End of 24 hours. *Oyſters in Vacuo.*

EXPERIMENT II.

A Craw-Fiſh being included in a Receiver, when the Air was pretty well exhauſted, ſeem'd dead, but reviv'd upon a Re-admiſſion of the Air; when the Air was again exhauſted, it was void of Motion; the Experiment being 3 or 4 times exhauſted, and Air let in again, when the Fiſh was taken out, it ſeem'd not to have ſuffer'd much harm. *A Craw-Fiſh in Vacuo.*

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EXPERIMENT III.

ANother Oyſter being ſhut up in a Receiver, and immers'd in Water, that the Bubbles which might come out of the Shell might be viſible, if any; we found that this Fiſh was ſo ſtrong, that no Bubbles could get out of the Shell.

EXPERIMENT IV.

A Craw-Fiſh ſtronger than the former, except one ſmall Intermiſſion, continu'd in Motion whilſt the Air was exhauſting.

TITLE VII.

Of the Phænomena *of a Scale Fiſh, in an exhauſted Receiver.*

A Gudgeon in Vacuo.

WE fill'd the Globous Part of a Receiver, which was ſhap'd like a Bolt-head, and large enough to hold a Pint, half full of Water, and put a Gudgeon 3 Inches long into it, which ſwam up and down; this being done, we exhauſted the Receiver ſo far, that but one part of twenty of the Air was drawn out, and then we obſerv'd the following Particulars.

Firſt, The Water, except about the Fiſh, afforded no Froth, and but few Bubbles.

Secondly, The Fiſh diſcharg'd ſeveral Bubbles at its Mouth and Gills, and ſeveral, after it reſted half an hour, ſtuck to its Fins and Tayl, and other Parts; theſe Bubbles by ſwimming would

would be ſhaken off, but upon a little Reſt, they would appear about him again.

Thirdly, Except at the latter End, he ſeem'd to take in Air at his Mouth and Gills.

Fourthly, After a while, he lay on his Back, and would ſwim in that Poſture.

Fifthly, In ſome time he mov'd more lively than at firſt. An hour and half after he was included, he ſeem'd clear of Bubbles, but lay on his Back, and was a little tumid, yet as lively as before. An hour and a ½ after he was without Motion, and ſtiff, yet being excited by Motion, he mov'd a little. Air being let into the Receiver, whilſt he was under Water, he ſunk to the Bottom, and ſeem'd a little reviv'd, and being conveigh'd along with the Water into a Baſon of freſh Water, he was further recover'd; yet could not lie on his Belly, but turn'd from one ſide to the other: his Belly ſeem'd much ſhrunk; he was alive at 24 hours end, and then was able to lie on his Belly.

TITLE VIII.

Of two Animals included, with large Wounds in the Abdomen, *in the Pneumatical Receiver.*

EXPERIMENT I.

A Small Bird, whoſe *Abdomen* was open'd tranverſly, in about a Minute after we began to Pump, had Convulſions in its Wings; and being taken out, was paſt Recovering, tho' *A Bird in Vacuo.*

there was very little Alteration in its Lungs, and the Auricles of its Heart continued to beat.

EXPERIMENT II.

A Frog in Vacuo.

A Frog, whoſe *Abdomen* was ſo much open'd, that two curl'd Lobes of its Lungs came out at the Inciſions, was ſuſpended by the Leg in a ſmall Receiver, which when it was in ſome Meaſure exhauſted, lay void of Motion, its *Abdomen* and Thigh being ſwell'd very much, as if diſtended with ſome Aery Vapour. One Lobe, when the Frog was ſhut up, appear'd full, the other ſhrunk up, and thus they continu'd, till Air was let into the Receiver again, and then the Body growing leſs tumid, and the Lobe of the Lungs which was tumid, ſubſiding, it preſently recover'd.

TITLE IX.

Of the Motion of the ſeparated Heart of a cold Animal in the exhauſted Receiver.

EXPERIMENT I.

The Heart of an Eel in Vacuo.

THE Heart of an Eel being ſhut up in a Receiver upon a Tin Plate, beat as in the open Air; and the Receiver being exhauſted, grew tumid, emitting ſeveral Bubbles out of it; yet it continu'd to beat as faſt, or faſter than in the open Air. The like Succeſs we had with another.

EP-

EXPERIMENT II.

THE Heart of another, tho' tumid, beat an hour in *Vacuo*, and then beginning to fail, I apply'd Heat to the Glaſs, upon which, it renew'd and continu'd it's Motions another hour; at which time, it's Motion was renew'd, by applying of Heat a ſecond time; at the end of the third hour, the Motion, which was but a trembling one, could neither be promoted by the Air, nor Heat.

TITLE X.

A Compariſon of Times, wherein Animals may be kill'd by drowning, or withdrawing of the Air.

EXPERIMENT I.

Sept. 10.

A Green-Finch being ſunk in Water by a Weight, was dead after it had lain half a Minute without Motion. *Animals in an exhauſted Receiver*

EXPERIMENT II.

A Sparrow, which at the firſt moved very vigorouſly under Water, being taken up, after it had lain half a Minute without Motion, was paſt Recovery.

EXPERIMENT III.

A Mouſe being immers'd half a Minute, and ſome Seconds, after ſome faint ſigns of Life, tho not Convulſive, dy'd.

EXPERIMENT IV.

A Duck, being immers'd by a Weight, after it had lain quiet for a Minute, was a little uneaſie; but being quiet at the end of the ſecond Minute, we took it out, and in a little time it recover'd; but being immers'd again in freſh Water, it emitted ſeveral Bubbles at its Beak and Noſtrils; and in two Minutes time, began to ſtruggle: At the end of four Minutes ceaſing to emit Bubbles, it began to gape, which continu'd two Minutes, and then its Head hanging careleſly down, it ſeem'd dead; being taken out a Minute after, it was paſt Recovery.

EXPERIMENT V.

A Duckling being immers'd with its Beak about 2 Inches under Water, emitted Bubbles at its Beak, which likewiſe aroſe from ſome place in its Neck, about as far from its Eyes as from its Ears, after which, ſeveral times it endeavour'd to dive lower, and having been moderately convuls'd, hung its Head down, as if dead at 3 Minutes end; ſoon after, a trembling Motion appeared in ſome parts of its Bill, but that ceaſing, at the end of the 4*th* Minute, it was taken out paſt Recovery.

EX-

EXPERIMENT VI.

A Viper was ſo long kept in *Vacuo*, that it ſeem'd dead; but, being kept all night over a digeſtive Furnace in a Glaſs Body, was as lively as ever. Then we immers'd it in a Glaſs Body ſtopp'd with a Cork, and depreſs'd with a Weight; where it lay a conſiderable time, with very little Motion; when four hours were almoſt paſt, it ſwam above the Bottom of the Water, and had ſeveral times put out its Tongue; when a little more than ſeven hours were paſt, it ſeem'd dead, its Head and Tail hanging down without Motion.

N. B. Tho' ſeveral of theſe Animals ſeem to die a little ſooner in Water, than in *Vacuo*; yet it does not certainly prove, that the former kills them faſter, for in Water they are depriv'd of Air inſtantly; In a Receiver, by degrees; which is evident from hence, *viz.* That having provided a Receiver which could be exhauſted at one ſuck, the Animal contain'd in it would be dead in half a Minute.

TITLE XI.

Of the Accidents that happen'd to Animals in Air brought to a Conſiderable Degree, but not near the utmoſt one of Rarefaction.

EXPERIMENT I.

Aug. 18.

A Linote being 3 hours in a Receiver, large enough to hold 4½ Pints, ſeem'd ſick; but being taken out, recover'd. *Several Animals in Vacuo.*

EXPERIMENT II.

Aug. 18.

A Linote being enclos'd in a Receiver half exhauſted, was not in danger of Death in leſs than 1½ hour, and then being expos'd to the Air, Recover'd.

EXPERIMENT III.

Sept. 9.

A Lark being included in a Receiver of the former Magnitude, together with a Gage; when ⅔ of the Air was exhauſted, in a Minute and half was taken with Convulſions, and at the end of the ſecond Minute, was paſt Recovery.

EXPERIMENT IV.

Sept. 9.

A Green-Finch being ſhut up in the ſame Receiver, half exhauſted, in a Minute was ſick, and threw Matter, which ſhe vomited, upon the ſide of the Glaſs; upon which, ſhe ſeem'd better, and continu'd ſo for 3 Minutes, and then being ſick, and vomiting as before, ſhe eat part of it up, and ſeem'd again to recover; ſome Air getting in, though it was pump'd out again, for the laſt Eight Minutes, ſhe ſeem'd better than we expected. At the end of a quarter of an hour, the Bird being not like to die, we took her out.

EX-

EXPERIMENT V.

A Viper, together with a Gage, being included in a Receiver, which held 3⅛ Pints of Water, for 36 hours after it was exhauſted, mov'd up and down nimbly, and put out her Tongue often: At the end of 60 hours ſhe ſeem'd almoſt dead, and the next day at Noon was quite dead. The Receiver taking in as much Water as the included Air would admit, by meaſuring it, we found that 5 parts of ſix of the Air had been drawn out.

A Digreſſive Experiment concerning Reſpiration on the Tops of High Mountains.

Upon Enquiry I was told, that the Mountains in *Armenia* are ſo high, that they cannot get to the Tops of them for Snow, and that thoſe that go up high, are troubled with a ſhortneſs of Breath. And the like difficulty of Breathing hath been obſerv'd on a Mountain in the Country of *Sevenes*, in or near the Province of *Languedoc*. And one that had been on the Top of *Pic de Midi*, one of the higheſt *Pyrenean* Mountains, obſerv'd the like ſhortneſs of Breath: And the Air on the Mount *Teneriff*, hath ſo violently affected ſome, that they were not able to climb to the Top of it. *Of Reſpiration on the Tops of Mountains.*

TITLE XII.

Of the Obſervations produc'd in an Animal in Changes, as to Rarity and Denſity, made in the ſame Air.

TO try whether an Animal that was almoſt dead, by being contain'd in rarifi'd Air, would recover upon a Condenſation of that, without admitting any freſh Air to come to it; we took a Lamb's Bladder, whoſe outſide being oyl'd, to render it more tranſparent, we cut ſo much of it's Neck off, that way might be made for a Mouſe to be put in; which being done, that the Neck of the Bladder might be ty'd up ſo, that no Air could get in at the Wrinkles, we cover'd a Wooden Stopple with Cement, which ſqueezing into the Crannies, we could utterly exclude the Air.

A Bladder thus prepar'd, being conveigh'd with a Mouſe in it, into a Glaſs Receiver, we ply'd the Pump, till the Glaſs Veſſel was ſo much exhauſted, and the Air in the Bladder ſo far expanded, that the Mouſe was like to die. Upon which, the rarifi'd Air in the Bladder being again condens'd, by admitting External Air into the Receiver, the Mouſe was reviv'd. The Experiment was a ſecond time try'd with the like Succeſs.

TITLE XIII.

Of an unſucceſsful Attempt to prevent the Neceſſity of Reſpiration, by the Production *or* Growth *of Animals in our Receiver.*

EXPERIMENT I.

A Good Company of Tadpoles being ſhut up in a Receiver, upon the firſt Exſuction, they roſe to the Top of the Water; and tho they ſubſided again, yet upon the ſecond, they roſe again, and ſeem'd to be diſcompos'd; when the Receiver was exhauſted, they ſwam upon the Top, being not able to dive down; and in an hours time, they became deſtitute of Motion; when the Air was let in, they ſunk to the Bottom, but recovered not. *Reſpiration neceſſary abſolutely continue Life.*

EXPERIMENT II.

THE like Experiment being try'd with a leſs number in a leſs Receiver, tho' they were ſupply'd with Air ſooner than the others, yet very few recover'd.

EXPERIMENT III.

THE ſame Experiment with the firſt, being try'd ſome Years after in another Receiver, we had the ſame Succeſs.

EX-

EXPERIMENT IV.

WE included ſome of thoſe Inſects in a Receiver with Water, which firſt live in Water, and then turn winged Inſects; which ſwimming up and down a few days, put off their *exuviæ*, and were perfect Gnats, which ſtood upon the Water, and liv'd a conſiderable time.

A digreſſive Experiment *concerning the Expanſion of Blood and other Animal Juices.*

The Blood and other Humors expanded.

Lamb's Blood preſerv'd from Coagulation was conveigh'd into a Receiver in a wide mouth'd Glaſs: When the Receiver was pretty well exhauſted, the more ſpirituous Parts of the Blood making their way out, rais'd the more clammy Parts into large Bubbles; and the Expanſion of the volatile Parts were ſo vehement, that it boil'd over a Glaſs, of which it fill'd but ¼ part. Having included warm Milk in a Cylinder 5 Inches high, the Quantity of it being only 3 Ounces, it boil'd ſo impetuouſly when the Air was totally exhauſted, that ſeveral parcels of it flew out of the Veſſel. Gall diſcover'd a greater degree of Intumeſcence.

N. The deſign of theſe Experiments was to know, whether when the Air is drawn out of a Receiver, Animals may not be prejudic'd by an Expanſion of the Humors in the Capillary Veſſels, as well as by an Abſenſe of Air, ſince the Parts of them diſtending the Veſſels may, ſtop Circulation, and cauſe Pains and Convulſions.

I once obſerv'd a Bubble to move to and fro in the Humors of one of the Eyes of a Viper in our exhauſted Receiver.

Another Digreſſive Experiment.

The Liver and Heart of an Eel, together with the Head and Body of another, being conveigh'd into a Receiver; when the Air was exhauſted, the Liver manifeſtly ſwell'd, and ſeveral Bubbles ſeem'd to ariſe from the *Medulla Spinalis*, or the Parts adjoyning. The Air being let in, the ſwollen Parts ſubſided, and the Skin ſeem'd more flaccid than before.

TITLE XIV.

Of the Power of Cuſtom to enable Animals to hold out in Air too much Rarified for Reſpiration.

EXPERIMENT I.

The Prevalency of Cuſtom to enable Animals to continue in Vacuo.

A Small Mouſe being conveigh'd into a Viol with a Wide Neck, a Bladder was ty'd upon it, which had all the Air expreſs'd out of it. This being conveigh'd into a Receiver with a Gage; a fourth part of the Air was only remaining in it; upon which, the Bladder was half diſtended with rarifi'd Air, and the Mouſe was very uneaſie, and ill; but that rarifi'd Air by an Ingreſs of External Air being condens'd, it preſently recover'd.

EX-

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A Small Mouſe being conveigh'd into a Viol with a Wide Neck, a Bladder was ty'd upon it, which had all the Air expreſs'd out of it. This being conveigh'd into a Receiver with a Gage; a fourth part of the Air was only remaining in it; upon which, the Bladder was half diſtended with rarifi'd Air, and the Mouſe was very uneaſie, and ill; but that rarifi'd Air by an Ingreſs of External Air being condens'd, it preſently recover'd.

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EXPERIMENT II.

THE Experiment being repeated, and the Mouſe kept in the rarifi'd Air four Minutes, was very ill, and with much difficulty recover'd in the outward Air, trembling for a long time.

EXPERIMENT III.

THE ſame Mouſe being again ſhut up, was a quarter of an hour in rarifi'd Air, and when taken out, ſooner recover'd than before, and with leſs trembling.

EXPERIMENT IV.

THE ſame Mouſe being again conveigh'd into a Receiver, after it had recover'd its Strength, the Air was a little further rarifi'd than before: At the firſt, the Mouſe ſeem'd diſcompos'd; but after continu'd quiet a quarter of an hour. The Air being expanded by three Exſuctions more, it ſeem'd ready to die, but Air being let in again, it preſently recover'd.

TITLE XV.

Some Experiments ſhewing, that Air, become unfit for Reſpiration, may retain it's wonted Preſſure.

EXPERIMENT I.

Air unfit for Reſpiration retains it's uſual Preſſure.

A Mouſe being ſhut up in an Oval Glaſs hermetically ſeal'd, and a Gage ſuſpended by a Wire in the Neck, in 2¼ hours we found it dead; and with much ado recover'd, when Air was blown in with a pair of Bellows, the ſeal'd end of the Glaſs being broken off. The Station of the Mercury in the Receiver was not alter'd.

EXPERIMENT II.

THE ſame Experiment being try'd with a ſmall Bird, in half an hour it was ſick and drooping, and in 2¼ hours a difficulty of breathing gradually increaſing, it dy'd. The Gage was not ſenſibly alter'd.

EXPERIMENT III.

TO ſhew that it is not a defect of Cold in an exhauſted Receiver, that kills Animals included in it. We hermetically ſeal'd a ſmall Bird in a Receiver, large enough to hold 3 Quarts of Water; In a few Minutes it began to be ſick and pant, and continu'd ſo half an hour: The Viol was immers'd 6 Minutes in Water refrigerated with a Solution of *Sal Armon.*

but

but the Bird was not refreſh'd; it vomited and purg'd, when taken out of the Water; and continuing to pant as before, in an hour from her firſt Impriſonment, dy'd.

TITLE VI.

Of the Uſe of the Air to elevate Steams of Bodies.

The uſefulneſs of Air to raiſe Steams from Bodies contiguous to it.

TO prove that the Air carries off the fuliginous Steams from the Lungs in Reſpiration; We prepar'd a Red Liquor, conſiſting of ſuch Saline and Spirituous Parts, as the Maſs of Blood yields: This Liquor well ſtopp'd up in a Bottle, tho' it be but half full, emits no Steams; but when the External Air comes to it, it emits white Exhalations, which riſe up into the Air. Whence it appears, that the Contact of the Air, may enable Bodies to emit Vapors.

In this Liquor there are two things worth our Notice; the Firſt is, that when the Viol hath lain quiet and ſtopp'd a competent time, the upper Part will appear void of Fumes, ſo that the Air will retain but a certain Quantity; which may help to give a Reaſon, why the ſame Air which will be clogg'd with Steams, in a ſhort time becomes unfit for Reſpiration.

The Second is, that in *Vacuo* for want of Air, tho' the Bottle was unſtopp'd, theſe Exhalations would not riſe; but as ſoon as it was let into the Receiver, they riſing up plentifully, were drawn out along with the Air, a ſecond time exhauſted. This Experiment hath ſome Affini-

ty

ty with that Mentioned in the 29 of the Experiments of the *Spring*, *and the weight of the Air* in the firſt Volume, that being made with Corroſive Ingredients, and this of Medicines good for the Lungs.

TITLE XVII.

Of the long Continuance of a Slow-worm, *and a* Leech *alive in the* Vacuum *made by our Engin.*

EXPERIMENT I.

A Slow-worm and a Leech alive in Vacuo.

WHite Snails without their Shells, being ſhut up *in Vacuo* had ſtore of Bubbles ſticking to them; but they put out and drew in their Horns at pleaſure; in ſome Hours they became void of Motion and Tumid; And in the ſpace of Twelve hours ſeem'd like blown Bladders, the ſubſtance of their Bodies being conſumed; The External Air being let in, they ſunk together like two Skins, no ſigns of Life appearing,

EXPERIMENT II.

AN Eft being included in an Exhauſted Receiver 48 hours, it ſeem'd ſwelled in it's Belly; it's under Jaw moved the firſt Night, but not after. The Receiver being opened under Water and half filled, the Animal was very much revived.

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EXPERIMENT III.

A Leech being included with a little Water in a Receiver, large enough to hold 12 Ounces; when the Air was Pumped out, the Leech keeping under Water, ſeveral Bubbles roſe from diſtinct parts of it's Body, yet it was not much indiſpoſed. It continuing well five days, by opening the Receiver under Water, I found that it had been all the time well exhauſted.

TITLE XVIII.

Of what happen'd to ſome Creeping Inſects in our Vacum.

EXPERIMENT I.

Creeping Inſects in Vacuo.

SIX Caterpillers being ſhut up in *Vacuo*, two hours after, moved up and down: 8 hours after they ſeemed quite dead; but being expoſed to the Air in the Morning were alive.

EXPERIMENT II.

CAterpillers being Shut up in two Receivers, to one we added the Air which was drawn out of the other Receiver. Thoſe which had Air with them, were alive two days, the others in *Vacuo* ſeem'd dead in a little time.

TITLE

TITLE XIX.

Of the Phænomena *ſuggeſted by Winged Inſects in our* Vacum.

EXPERIMENT I.

Winged Inſects in Vacuo.

FLeſh-Flies whoſe head were cut off, being included in a Portable Receiver, furniſhed with a large Pipe and a Bubble at the end of it; When the Air was drawn out, they loſt their Motion; two hours after, Fire not being able to excite Motion in them, I let in the Air, and then they began to move; and were obſerved to move the next Morning.

EXPERIMENT II.

SEveral Ordinary *Flies* and a *Bee* or *Waſp*, lay as if dead in the exhauſted Receiver, except ſome, which for a few Minutes were Convulſive; after 48 hours, they neither Recovered when expoſed to the open Air, nor the Meridian Sun.

EXPERIMENT III.

A great Fleſh Flye being put into a Portable Receiver was very brisk and lively till the Air was drawn off, but then was taken with Convulſions; the Air being let in again ſhe Recovered, but it being a ſecond time exhauſted, ſhe lay

as dead till the Glaſs was ſtirred, and then ſhe moved a little; the next Night after neither heat nor any thing elſe would recover her of a long time; but at the laſt, when ſhe was well, being ſhut up again 48 hours and placed in a Warm place, ſhe grew ſo ill as to be paſt Recovery.

EXPERIMENT IV.

A Graſs-hopper whoſe Body was an Inch long, being ſhut up in an oval receiver large enough to hold a Pint; when the Pump was firſt Plyed he was very uneaſie, and ſeveral Liquid drops came from his Abdomen to the quantity of a quarter of a Spoonful; when the Receiver was pretty well exhauſted he fell on his back and lay as dead. But the Receiver being plac'd in the Sun-ſhine he moved a little, and ſoon after lay as dead 3 hours. But the Receiver being open'd and placed, after he ſeem'd dead half an hour, ſome time in the Sun beams, in a ſhort time he recovered.

EXPERIMENT V.

A Roſe-Flie being ſhut up in a receiver, ſtrugled much whilſt the Receiver was exhauſting, but in 6 hours time ſeem'd dead; the Receiver being opened Four hours after, the Beetle was lively enough. The Receiver being a Second time exhauſted, the Animal in the mean time ſeemed much diſquieted.

EXPERIMENT VI.

SEveral Butterflies being Shut up in *Vacuo*, were not able to flye in ſo thin a Medium, but

but when the Receiver was inverted, would fall from one end to another rudely enough.

TITLE XX.

Of the Neceſſity of Air to the Motion of ſuch ſmall Creatures as Ants *and even* Mites *themſelves.*

ANts being ſhut up in *Vacuo*, in Seven hours time ſeem'd dead; but the Receiver being opened, about 14 hours after they were moſt of them Recovered. *Air requiſite to the Life of very Minute Animals.*

Cheeſe, which had a great many Mites in it, was convey'd into Four ſeveral Receivers, Three of which were exhauſted: The Mites in the unexhauſted Receiver were alive a Week. In two of the exhauſted Receivers they ſeem'd dead, and continued ſo Four hours; but Air being permitted to ruſh in 3 days after, ſeveral of them were revived, and continued alive 2 or 3 days longer. In the other Receiver Mites which lay dead 3 days Recovered preſently upon a Re-admiſſion of the Air.

CHAP. VI.

The moſt Conſiderable Animadverſions on Mr. Hobbs's *Problemata* de Vacuo.

THe firſt Paſſage in Mr. *Hobbs*'s Problemata *de Vacuo* taken Notice of is this, *Viz.* He ſays, if a *Vacum interſperſum*, were allow'd in the Air, when two Flat Marbles are exactly adapted to each other's Superficies, they might as eaſily be ſeparated, as moved, when ſeparate in the open Air. To which it is Anſwered, that tho' there be ſeveral Vacuities interſperſed betwixt the Particles of an Atmoſpherical Pillar of Air; yet notwithſtanding, ſince each of thoſe Particles are endued with a Specifick gravity, and are incumbent on the ſurface of the uppermoſt Marble, whatever ſeparates thoſe two Bodies, muſt have a force able to ſuſtain the weight of the Pillar of Air which leans on it. But when the Air is contiguous to each ſide of the Marble, having an equal Preſſure on each ſide from the Ambient Atmoſphere, there is required no more force to move it up and down, than is ſufficient to ſurmount the Weight of it, *&c.*

Why contiguous Marbles are not eaſily ſeparated.

And tho' Mr. *Hobbs* ſays, that the Reaſon why two Marbles cannot be Separated ſuddenly,

ly, is, becauſe the Air cannot inſtantly fill the ſpace deſerted by them; yet from Experiments already laid down; it appears, that they may be pulled aſunder, and much more eaſily, in an exhauſted Receiver where there is no Air to ſucceed the ſpace left betwixt them upon their Avulſion. Where it is evident, that a force able to overcome the hardneſs of the Stone, is not requiſite to draw them aſunder, but only ſo much as is able to raiſe the Weight of the upper Marble; and in the open Air as much as is ſufficient to over-power the incumbent Atmoſphere.

Another Argument againſt what Mr. *Hobbs* lays down in favour of a Plenitude, may be taken from the following Experiment. We took a Glaſs Bubble about as big as a Nutgmeg, and having Sealed up it's Stem, we held it in a Flame, and as ſoon as it was ready to Melt, removed it into the open Air, where the Bubble, which was dilated in the Flame by the help of the included Air's ſpring, was preſſed in on one ſide by the Weight of the Ambient Atmoſphere, the Rarified Air, being condenſed, and not able to reſiſt the Preſſure of the External Air; yet when the Bubble was again convey'd into the Flames, the Internal Air expanding plumped up the ſides of the Glaſs, which were again compreſs'd and bruiſed by the Weight of the open Atmoſphere; and this Experiment being tried a Third time, Anſwered as when Firſt repeated, till at laſt the one ſide of the Bubble had a hole made in it, by the violent Preſſure of the Atmoſphere; from whence it appears, that the ſame quantity of Air may, by being Rarified, and leaving Vacuities betwixt it's Rarified

Parts, be able to take up and posſeſs a larger ſpace; and that there muſt be Vacuities interſperſed betwixt the Parts of that Air, is evident, ſince the Pores of the Glaſs are too fine, to admit External Air, or when the Bubble was compreſs'd, to give way for an egreſs of the Air contained in it.

A Second Argument Diſcovered.

Mr. *Hobbs* aſſerting, that the Cavity of a Receiver exhauſted, is full of Air, the firſt Experiment here alledg'd againſt him, and which ſhews, that the Weight and preſſure of the *Atmoſphere* is very conſiderable is this: A Pewter Porringer being cemented down upon an Iron Plate, which was fixed to the Pump, we drew out the Air, upon which the Incumbent *Atmoſphere* depreſs'd the Convex ſurface of the Porringer, and rendred it Concave; and in another Tryal I took Notice, that the *Atmoſphere* did not exert its Gravity in a perpendicular Line, but collaterally.

The Reaſon of Bubbles in an exhauſted Receiver.

Mr. *Hobbs* aſcribing the Reaſon of thoſe Bubbles, which in an exhauſted Receiver, appear for ſome time upon the Surface of Water, to the violent Motion of the Air contained in the Receiver, Mr. *Boyle* to diſprove him, takes Notice that when Water is once freed from it's Air, let the Pump be Plyed never ſo violently, the violent Motion of Mr. *Hobbs*'s Air will not be able to cauſe Bubbles; ſo that the *Phænomenon* rather depends on a want of Air to preſs on the Surface of the Water, and to over-power the Expanſive force of that Air, contained in the Pores of it; which for want of ſuch a Preſſure makes it's way through the Water it's contain'd in.

Mr.

Mr. *Hobbs*'s Explanation of the *Torrecellian* Experiment having been elsewhere Answered, to what hath been their delivered, I shall add the following Experiment; The *Torrecillian* Experiment being Tried with a straight Tube, we raised the Pipe a little in the stagnant Mercury; and then conveying a piece of a Bladder under the End of it, and tying it firmly; when the end of the Tube was raised above the stagnant Mercury, I observ'd, that the Weight of the Mercury upon the Bladder was very slight, and the *Equilibrum* betwixt the Mercurial and *Atmospherical* Cylinder was so equal, that if the Tube was but inclined, so that the Weight of the Mercury was not Perpendicular, the *Atmosphere* would buoy up the Bladder, and form a Concave in the lower end of the Mercury; but when the Tube was Erected again, the Bladder would be depress'd, and become Protuberant: And if the Bladder was nimbly apply'd, when the Mercury was a little below it's wonted Station, the Mercury being then lighter than the *Atmospherical* Cylinder, the Bladder would be raised up into the Cavity of the Tube: In which Experiment we may Observe, that tho' upon the Ascent and Descent of the Mercury, the Cavity above it is accordingly varied in it's Dimensions; yet no Air can Ascend to fill it, as Mr. *Hobbs* would suggest, since the Bottom of the Tube is shut up with a Bladder, which as I have elsewhere made it appear, cannot be penetrated by Air.

Mr. Hobbs Explanation of the Torrecellian Experiment Examined.

Another Argument against Mr. *Hobbs*'s Explanation of the *Torrecellian* Experiment, is de-

deduced from an Obſervation made on the Travelling Baroſcope; for it is Obſerved, that when the ſhorter Leg is Sealed up with Air included in it, Heat will ſo Rarifie that Air, that it will elevate the Mercury in the longer Leg, without making it's way through the Mercury below, as Mr. *Hobbs* ſuppoſes it does in the *Torricellian* Experiment; where one would expect, that if Air condenſed could Penetrate Mercury ſo eaſily, the rarified Air would rather penetrate than buoy it up.

The Reaſon of Suction. To ſhew, in Oppoſition to Mr. *Hobbs*, how much the *Atmoſpherical* Air is concern'd in Suction, we took a Glaſs Bubble, whoſe long Stem, was Cylindrical and very ſlender, and having, by the help of heat, expelled a good quantity of the Air contain'd in it, when by immerging it in Water that Rarified Air which remained in it, was condens'd; the Water was almoſt raiſed to the Top of the Pipe; when this was done, the Air in the Bubble being Rarified, it forced out almoſt all the Water in the Stem, only a few Drops, which ſatisfi'd us that none of the Rarified Air had got out of the Pipe; as the Depreſſion of the Water ſo low aſſured us, on the other ſide, that the included Air was almoſt as much Expanded, as when the Water began to aſcend into the Pipe. When the Air was thus Rarified, we preſently removed the Pipe out of the Water into the Stagant Mercury, which aſcended into it in a ſhort time. In which Experiment, did the Mercury riſe to prevent a *Vacuum*, or did it's Aſcent, depend on any internal Principle of Motion, or on the compreſſion

and

and propagated Pulſion of the Air that was expelled, there would be no reaſon, why the Mercury ſhould not riſe as high as the Water. But from our Hypotheſis, the Reaſon is plain; for as ſoon as the Cylinder of Water or Mercury together with the compreſs'd Air is equiponderant with the *Atmoſphere* incumbent, it riſes no higer; So that tho' the Air is leſs condens'd, when the Tube is immers'd in Mercury; yet the greater Weight of Mercury making a greater reſiſtance than Water, the external Air is not able to buoy it up any higher to compreſs the Air enclosed.

And this Experiment is confirm'd by the following: For having expell'd a little Air out of the Bubble by heat, ſo much Quickſilver aſcended into it, as fill'd a Fourth Part of the Pipe; which being carefully removed, ſo that no Mercury could run out; we cauſed the Air in the globous part to be Rarified till almoſt all the Mercury was expell'd, the end of the Pipe being all the while immers'd in Water; as ſoon as the Air included began to cool, the Water roſe up into the Body of the Ball, buoying up the Mercury before it, whereit was obſerv'd, that as the Air was more or leſs Rarifi'd, and the Quickſilver exepll'd out of the Stem, the Aſcent, of the Water would proportionably vary. So that as the Body to be buoy'd up by the External Air varies in Weight, ſo do the Degrees of it's Aſcent.

Another Obſervation, which ſhews that there is no Circulation of Wind, ſuch as Mr. *Hobbs* ſuppoſes to be the Cauſe of Suction, is, that Smoak will aſcend without being in the leaſt blown about. But ſince Mr. *Hobbs* will not allow of a *Vacuum*,

Vacuum, but asserts, that the Air makes it's Way through the close and solid Bodies, I shall add, that having expell'd the Air by Rarefaction, out of a very thin *Æolipile*, and stopp'd the Orifice up with Wax; the External Air made such a violent Pressure on it, as to thrust the Sides of it considerably inwards.

CHAP. VII.

The Cause of Attraction by Suction.

Attraction, What.

Suction being look'd upon to be a sort of Attraction, before I descend to a more particular Consideration of the former, I shall premise something of the latter.

And tho' Attraction is generally taken to be a kind of Pulsion, yet both of them to me seem to be but extrinsical Denominations of the same Local Motion; in which, if a Body mov'd, precede the Movent, or tends to acquire a greater Distance from it, we call it Pulsion; and if upon the Account of Motion, the same Body either follows, or tends towards the Movent, it is term'd Attraction; so that the difference is no Physical one, but only *Accidental*, in respect of the Line of Motion to the Movent. As when a Man draws a Chain after him, tho' he goes before it, yet he hath some Part of his Body behind one Link, which draws the rest after it; and so if that Chain draws any thing after it, tho' the Cause of the Attraction

Attraction goes before, yet there is a certain Coheſion of Parts, that enables it to drag that Body after it; ſo that Attraction evidently appears to be a Species of Pulſion, and ſuch an one as is uſually term'd Truſion, as when a Gardiner drives his Wheelbarrow before him without letting go his Hold.

But perhaps it may be ſaid, that there are Attractions where it cannot be pretended that the Attrahent comes behind any Part of the Body attracted; as in Magnetical and Electrical Attractions, or as when Water riſes by pumping.

As for the two firſt Inſtances, ſhould we allow with Modern Philoſophers, of ſcrew'd Particles and other Magnetical Emiſſions, we might ſay, that theſe coming behind either the Body attracted, or it's porous Parts on it's Superficies might cauſe ſuch an Effect; or by procuring ſome Diſcuſſion of the Air, that may make it thruſt the moveable towards the Attracting Body. But were there none of theſe, nor any other ſubtil Agents, that cauſe this Motion by a real, tho' unperciv'd Pulſion; I ſhould, to diſtinguiſh theſe from other Attractions, term them Attraction by Inviſibles.

But as for the laſt Inſtance, I ſuppoſe it will be eaſily granted, that the aſcending Rammer only makes way for the Water to riſe, as it is buoy'd up by External Air; for from the *Torricellian* Experiment it is evident, that, ſince the Terraqueous Globe is continually preſs'd upon by the *Atmoſphere*, if in any part, that Preſſure be taken off, the Incumbent Atmoſpherical Pillar will buoy up as much of that Liquor, as a Pillar of Air of ſuch a Diameter is able to coun-

counterpoiſe: The Truth of which is further confirm'd by obſerving, that, if the Air from about a Syringe be exhauſted, the Sucker may be pull'd up without elevating the Water, or drawing it up after it. And indeed, ſuppoſing two Men, by thruſting equally on each ſide a Door, to keep it ſhut, one might as well ſay, that he that left off thruſting on one ſide, was the Cauſe of the Doors opening, as that the Water riſes by the drawing up the Rammer, which only gives way to the Water as buoy'd up by the External Air.

The Cauſe of Suction, as laid down by others examin'd.

Thus much being ſaid of Attraction, I ſhall proceed to conſider, that Species of it call'd *Suction*; for which ſeveral Philoſophers have thought on various Cauſes. As Nature's Abhorrency of a *Vacuum*, which, were it true, Water by Suction might be rais'd to any Height; but we have found by Experience, that it will not be rais'd above 33½ Foot, which Weight the *Atmoſphere* is able to buoy up; as appears from the *Torricellian* Experiment. And further from an Experiment elſewhere laid down, where, tho' Water may preſently be ſuck'd up to the Top of a Pipe 3 Foot long, yet Mercury being too heavy to be buoy'd up ſo high, it will not be elevated higher than an Atmoſpherical Cylinder is able to raiſe it.

But thoſe Modern Philoſophers who allow not a *Fuga Vacui*, aſcribe the Aſcent of ſuch Liquors to an Impulſe or Propagation of Motion, by the Dilation of the *Thorax*; for they think, that the Lungs drawing in the Air, the dilated *Thorax* propagates the Impulſe, till it reaches ſucceſſively the Body ſuck'd; for ſuch thinking the Univerſe totally a *Plenum*, think that ſuch Matter

ter not finding any other Place to move into, does upon that score buoy up the Water or Mercury in the Pipe. But if we consider, how vast the Dimensions of the Air are, and comparatively how inconsiderable an Impulse the *Thorax* by dilating can make, it will scarce be thought, that so slight a one will compress the whole Air, so much as to make it impel the Body suck'd vigorously enough to rise to that height, which Liquors may be rais'd to by Suction. But the Ascent of such Liquors evidently depends on this, that by Suction the Pressure is taken off the Surface of the Water, within the Pipe, and consequently, it must rise and be buoy'd up by the Pressure of the *Atmosphere*, on the stagnant Water.

To countenance my Opinion, and to refute the others I have mention'd, I shall offer the following Experiment, *viz.* A small Bubble with a Stem being seal'd up, when the Air was forc'd out by Rarefaction; the Stem was broke under Water, upon which the Water rush'd into the Cavity of the Bubble, where if it be said to go into the Bubble to prevent a *Vacuum*, those that say so, allow *dari Vacuum*, and subvert their own Principles; and as for the Plenists, upon the same Account we may ask them, what became of that Air which was expell'd out of the Bubble, and remain'd so, till the Stem was broke; since were the World an absolute *Plenum* before, there could be no room for it without, nor could there be such an empty Space within to receive the Water. Besides, if they say the external Air being condens'd and compress'd by that which is forced out of the Bubble, occasions the Re-

Re-ingreſs of Water when the Stem is broke off, it may juſtly be wonder'd, that a cubic Inch of Air ſhould be able to condenſe the Air ſo much, that a Mile's diſtance from the place the Bubble was evacuated in, it ſhould be able to preſs the Water thus in again. But by our *Hypotheſis*, it is accounted for without theſe Difficulties; ſince the Reſiſtance of the rarifi'd Air within the Bubble, being diſproportionable to the Preſſure of the leſs rarifi'd Ambient Air, it muſt conſequently yield to it, and give way to the Ingreſs of Water.

Our own Opinion propos'd and prov'd.

From what hath been ſaid, it plainly appears what our *Hypotheſis* is, which that I may confirm by the following Experiments I ſhall briefly intimate: That the Aſcent of Liquors by Suction, in a Word, depends on the External Preſſure of the Air, when it is taken off the internal Superficies of the Liquor in that Tube; what that Preſſure depends on we have elſewhere prov'd in our *Phyſico*-Mechanical Experiments of the Air's Spring and Weight, and therefore ſhall proceed to Experiments to confirm what we teach of *Suction*.

We took then a crooked Syphon, whoſe ſhorter Leg was parallel to the longer, which being hermetically ſeal'd, and ſo much Water conveigh'd into the crooked End, that it was of an equal Height in both Legs, ſo much Air was contain'd in the Cavity of the ſhorter Leg, as poſſeſſes an Inch and ½. The Inſtrument being thus prepar'd, one was order'd to ſuck at the Top of the longer Leg, and by all the Force and reiterated Suctions, he was not able to raiſe the Water higher than the Air in the ſhorter Leg depreſs'd

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the Surface of that; for when the Spring of that Air was ſo far weaken'd, that it could not depreſs the Water ſubjacent; the Water kept at the ſame Station, being not above four Inches high, which was not two Inches and an half higher than at firſt. But as ſoon as the External Preſſure of the *Atmoſphere*, was again admitted to the Surface of the Water in the longer Tube, it was preſently depreſs'd, and the Air in the ſhorter Leg condens'd, till the Water likewiſe roſe in that to it's firſt Station.

For a further Confirmation of our *Hypotheſis* about Suction, I ſhall ſubjoyn Experiments to prove the following Propoſitions.

I. *That a Liquor may be rais'd by Suction, when the Preſſure of the Air, neither as it hath Weight, nor Elaſticity is the Cauſe of the Elevation.* Our Hypotheſis reduc'd to Propoſitions.

II. *That the Weight of the Atmoſpherical Air is ſufficient to raiſe up Liquors by Suction.*

III. *That in ſome Caſes Suction will not be made, as, according to the* Hypotheſis *I diſſent from, it ſhould, although there be a Dilatation of the Suckers* Thorax, *and no danger of a* Vacuum, *tho' the Liquor ſhould aſcend.*

To make out the firſt Propoſition, I made the following Experiment, *viz.* I took an inverted Tube, ſuch as was formerly made uſe of, for a Travelling Baroſcope, but ſomething longer, which being fill'd with Mercury, it was inverted, and the Mercury in the longer Leg ſtood above the Mercury in the ſhorter Leg, as high as it uſually does in an ordinary Barometer; and then, one was order'd to ſuck at the ſhorter Leg, upon which *The firſt Propoſition prov'd.*

which the Mercury ſubſided in the longer, and roſe in the ſhorter; the Mercury in the longer by it's own Weight depreſſing the ſubjacent, and raiſing that, when the equivalent Weight of the *Atmoſphere* was taken off.

The ſecond Propoſition prov'd. As for the ſecond Propoſition laid down, *viz. That the Weight of the Air is ſufficient to raiſe Liquors in Suction*; It may eaſily be prov'd by Arguments drawn from our *Phyſico-Mechanical* Experiments, and therefore here I ſhall only take notice of *Phænomena* exhibited by our *Travelling Baroſcope*; for having got a *Baroſcope*, whoſe ſhorter Leg was ſomething longer than ordinary, we caus'd one by Suction to raiſe the Mercury up to the Top of it, and then hermetically ſealing it up, we mark'd the place to which the Mercury had ſubſided in the longer; which being done, we unſeal'd the ſhorter Leg, and obſerv'd, that the Preſſure of the *Atmoſphere* elevated the Mercury in the longer Leg 5 Inches.

The third confirm'd. For a further Confirmation of the Doctrin laid down in this Propoſition, I ſhall ſubjoyn the following Experiment. We made uſe of a Travelling Baroſcope, whoſe ſhorter Leg was 2 Inches above the Surface of the ſtagnant Mercury; and having ſeal'd up the End of the ſhorter Leg, we open'd the End of the longer; upon which, the Weight of the *Atmoſphere* being added to the Preſſure made by the Cylinder of Mercury, the Air contain'd in the ſhorter Leg was compreſs'd into half the Space it poſſeſs'd before. This Experiment being try'd a ſecond time had the like Succeſs.

To make it further appear, how much the Aſcent of Liquors depends on Preſſure. I took

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a Glaſs Syphon like the former, and having hermetically ſeal'd up the ſhorter Leg, I pour'd in ſo much Mercury as compreſs'd the Air in the ſhorter Leg, into half the Space it poſſeſs'd before; the Mercury in the longer Leg being at the ſame time, about 30 Inches higher than in the other; nevertheleſs, the Mercury could not be rais'd by Suction above one Inch higher in the longer Leg; whereas, did the Aſcent of Liquors depend on Nature's Abhorrency of a *Vacuum*, it would have roſe much higher, there being no danger of leaving a *Vacuum* in the ſhorter Leg, ſince the Air was compreſs'd into half the Space it naturally poſſeſſes; ſo that the Reaſon according to our *Hypotheſis* evidently appears to be this, *viz.* that the Preſſure of the Cylinder of Mercury, and the compreſs'd Air being in a *due Æquilibrium*, when, by ſucking, the Air is drawn out of the longer, the Air in the ſhorter expands it ſelf ſo much, as Preſſure is taken off by the Removal of that Air, and when it is expanded ſo far, the Pillar of Mercury keeps it from expanding any further, ſo that, there being no other Force to raiſe and preſs the Mercury up, it can be elevated no higher, ſince the Air included in the ſhorter Leg acts only by Virtue of it's Spring, and not as in the open *Atmoſphere*, by Virtue of it's Spring and Weight too, ſo when it hath loſt it's Spring, it can propel the Mercury no higher.

To conclude this Diſcourſe, I ſhall here explain one *Phænomenon* in *Vacuo Boyliano*, which to ſome ſeems an Argument of Nature's Abhorrency of a *Vacuum*. The *Phænomenon* is, That if ones Finger be apply'd to the Orifice of the

Pipe, that conveighs Air from the Receiver to the Pump, the Pulp of one Finger, will enter a good way into the Pipe, and be very painful; the Protuberant Part of it ſeeming to be drawn in by Attraction. To which we give this brief Anſwer, *viz.* That when firſt the Finger is plac'd there, it receives an equal Preſſure from the Air within the Pipe, and from the *Atmoſphere*; but when that Air is drawn away, the External Preſſure finding no Reſiſtance, preſſes the fleſhy Part into the Tube, which is accordingly painful, as the External Preſſure in reference to the internal Reſiſtance is greater or leſs.

To illuſtrate this Explication, I ſhall add, that having clos'd up one End of a Glaſs Pipe, whoſe Diameter was an Inch, with a piece of oyl'd Bladder, and fill'd it full of Water; it was immers'd in a tall Veſſel full of Water, the immers'd End of the Tube reaching almoſt to the Bottom of the Veſſel, and the other End emerging, and ſtanding open above the Veſſel: This being done, we took Water out of the Tube, till the Surface of it was conſiderably lower than the Surface of the Water in the Glaſs Body; upon which, the Bladder being more ſtrongly preſs'd againſt by the Water in the Veſſel, than that in the Tube, the Bladder was forc'd ſo much into the Cavity of the Tube, as to form a Semi-Globe; but if, when the Water in the Tube, and that in the Veſſel were equally pois'd, the uppermoſt Orifice of the Tube were ſtopp'd, tho' the Pipe were ſo much immers'd, that the Quantity of Water, which preſs'd againſt the lower ſide of the Bladder, were greater

er than that in the Tube; yet would not the Bladder have the leaſt Protuberance; but if the Orifice of the Tube were left open to the Air, the Bladder would ſuddenly be preſs'd ſo much into the Hollow of the Pipe, that it's Convex Superficies would repreſent a Semi-Circle. The ſame Experiment being try'd with a Tube, the lower End of which was ſo bent, as to form a right Angle, the Succeſs was the ſame: Nor did it vary when try'd in the ſtraight Pipe, with Wine inſtead of Water, ſave that Wine not being ſpecifically æque-ponderant with Water, a greater Quantity of Wine was requiſite to ſettle them, at firſt, in a juſt *Æquilibrium*; but when that *Æquilibrium* was loſt, by immerging the Tube into the Water, the Bladder was rais'd, ſo as to become protuberant in the Cavity of the Pipe.

CHAP. VIII.

Some Obſervations and Directions about the Barometer, *communicated by* Mr. Boyle, *in the* Phil. Tranſact. *of* April 1666.

Obſervations concerning Barometers.

THE Deſign of trying Barometrical Experiments in ſeveral Parts, being only that by comparing Notes, *The Extent of Atmoſpherical Changes, in Point of Weight, might be the better eſtimated*; I ſhall lay down the following Directions for thoſe, whoſe Curioſity leads them that way. *Firſt*, It will be requiſite to note the Day and Hour in which Obſervations are made. *Secondly*, The Situation of the Place where the *Barometer* ſtands as to Height, ſince by the

Length of the Atmosperical Pillar of Air that presses upon it, the height of the Mercury may vary; tho' not always exactly; for sometimes upon Changes in the Air not otherwise observable, the Mercury will subside more than usually in that which stands furthest from the Center of the Earth, when at the same time it does not proportionably subside in that which is plac'd in a lower Situation. And

It, perhaps, may be Worth Noting, whether upon excessive Droughts, when the Ground is parch'd and crack'd, some subterraneal *Effluvia* may not rise, which may add a specifick Gravity to the Air.

Nor will it be needless, when other Observations are making, at the same time to observe the Weather; as also what Winds blow, and whether violent or more remiss; for sometimes it is obsery'd, that when high Winds blow, the Mercury is the lower, tho' not always.

But to favour what hath been intimated, viz. That the Alterations in the Weight of the Air, depend on subterraneal Steams mix'd with it; It hath been obsery'd, that after long Droughts, upon a Shower of Rain, so many Steams have been either prevented from rising, or depress'd and precipitated, that the Mercury hath subsided within $\frac{1}{4}$ of an Inch.

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CHP. IX.

An Account of a new kind of Baroſcope which may be call'd Statical: *communicated in the* Philoſophical Tranſactions *of* July 2. 1666.

A new Baroſcope deſcrib'd.

HAving caus'd a Glaſs Bubble to be blown, as large and thin as it poſſibly could be; I counterpois'd it in a Pair of Scales, which would turn with the 30*th* Part of a Grain; which Ballance being ſuſpended at a Frame, both the Frame and the Ballance were placed by a good Baroſcope, from whence the preſent Weight of the *Atmoſphere* might be learnt. By which means I could diſcern Variations, by which the Altitude of the Mercury was not alter'd above ¼ of an Inch. And it was not a little pleaſant to behold, that ſometimes the Bubble would be counterpois'd; but when the *Atmoſphere* was very high, it would manifeſtly preponderate, and upon other Changes the Scales would preponderate on the other ſide, and in ſome Days time again regain it's *Æquilibrium*; ſo that by looking firſt on the ſtatical Baroſcope, one might foretel, whether in the Mercurial Baroſcope the Water were higher or lower; but of all the Seaſons we made our Obſervations in, the moſt frequent Changes were in the Spring.

This ſtatical Baroſcope having exactly anſwer'd upon frequent Obſervations, I ſhall add the following Notes concerning the Inſtrument.

And firſt, as to the Grounds on which I proceeded in making this Baroſcope. 1. That the Glaſs Bubble and it's Glaſs Counterpoiſe are not

of the ſame Bulk, the Bubble being a hundred times bigger than the Counterpoiſe. 2. If Bodies of equal Weight and unequal Bulks be weigh'd in another *Medium*, the *Æquilibrium* will be loſt; for if the new *Medium* be heavier, the Body whoſe Dimenſions were larger, will be lighter than before; and *Vice versâ*, and the Diſparity of Weight in the new *Medium* will be greater, as the Inequality of Bulk betwixt the two Bodies varies. 3. Theſe two things being laid together, I conſider'd, that it would be the ſame thing in reference to the Effects, what *Medium* theſe Bodies were weigh'd in, provided the difference were conſiderable; and conſequently, ſince the Baroſcope made it evident, that the Weight of the Air vary'd, the Bubble and it's Counterpoiſe would be differently affected upon thoſe Variations, and would accordingly preponderate, the Bubble being ſubject to preponderate when the Air was lighter; and *Vice versâ*.

Secondly, The Bubble was about the ſize of a large Orange, and weig'd 1 Drachm and 10 Grains.

Thirdly, If I had had any Opportunities, I would have try'd whether the *Æquilibrium* of theſe two Bodies would have been alter'd, by the Drineſs or Moiſture of the Air.

Fourthly, When I could not get one Bubble large enough, I have made uſe of two leſs, which tho' they are not altogether ſo convenient, yet, if the Scales be ſtrong enough to bear the Weight, they will anſwer the Deſign of the Experiment.

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This Inſtrument may be improv'd by ſeveral Accomodations. As,

Firſt, To the *Anſa* of the Ballance, an Arch of a Circle may be fitted, which being divided into 15 or 20 Degrees, will readily tell the Quantity of the Angle, and how much the Poſition of the Cock declines from a Perpendicular.

Secondly, A Counterpoiſe of Gold may be made uſe of.

Thirdly, The Ballance being made of Copper or Braſs, will in time vary leſs in it's Exactneſs, than if it be made of Steel, which is more ſubject to ruſt.

Fourthly, The Bubble and it's Counterpoiſe may be ſuſpended at the Beam, by which means it will be leſs burthen'd with Weight.

Fifthly, The whole Inſtrument will be more free from Duſt and irregular Agitations, if placed in a Frame, like a Square Lanthorn, with Glaſs Windows and a Hole at the Top to give an Intercourſe betwixt External and Internal Air.

Sixthly, This Inſtrument having a light Wheel and an Index fitted to it, ſuch as Dr. *Wren* us'd to open Weather-Glaſſes with, and the Ingenious Mr. *Hook*, apply'd to Baroſcopes, will diſcover more minute Variations.

Seventhly, The Beam may be improv'd by being made longer, and it's Ballance may be more exquiſite than thoſe I generally employ'd.

Thus, tho' this ſtatical Baroſcope be inferior to the Mercurial one in ſome Reſpects, yet in others it is more convenient; For

First, It demonſtrates to Autopſie, that the Aſcent and Deſcent of the Mercury, depends on the varying Weight of the *Atmoſphere*; ſince here it cannot be pretended, that the Changes depend on a *Fuga Vacui*. *Secondly*, It ſhews that the Air hath Weight, and much more than ſome Learned Men would allow; ſince in ſo ſmall a Quantity of it, we ſee conſiderable Variations. *Thirdly*, It is more eaſily provided; and more conveniently removed. *Fourthly*, We are more eaſily ſatisfied of the Goodneſs of them. *Fifthly*, The *Abſolute* or *Reſpective* Weight of the Air may more eaſily be diſcover'd; if, when the Weight and Dimenſions of the Bubble is Hydroſtatically diſcover'd, upon every Alteration of the Mercury's Height in the mercurial Baroſcope, the ſtatical Baroſcope's *Æquilibrium* be reſtored by the Addition of Weights; that Weight in the ſtatical Baroſcope anſwering the Variations in the Aſcent or Deſcent of the Mercury in the other. *Sixthly*, By this Inſtrument, we may compare the mercurial Baroſcopes of ſeveral Places, and be able to make ſome Eſtimate of the Gravities of the Air therein; for, if in one place the Bubble weighs a Drachm, when the Mercury is 29½ Inches high, and that when the Mercury is riſen an 8*th*, it is requiſite to add the ſixteenth Part of a Grain to preſerve the *Æquilibrium*; When I come to another Place, and find the ſame Proportions anſwer, I may conclude, that there is no ſenſible Difference in the Weight of the *Atmoſphere* in thoſe Places; but if an additional Weight be requir'd to preſerve the *Æquilibrium*, then the Air is ſo much heavier,

vier, than when the Mercury ſtood at 92¼ Inches.

But in making theſe Obſervations we muſt take notice, whether the Places in which they are made, are equally diſtant from the Center of the Earth; for if one be a Valley, and the other a Hill, there will happen a difference upon that Account.

There is yet another uſe which may be made of this ſtatical Baroſcope, which is, to diſcover the Weight of the *Atmoſphere* at the Top and Bottoms of high Mountains; but whether that may contribute to the diſcovering the Height of Mountains, or not, I ſhall leave to be conſider'd with more leiſure.

CHAP. X.

A Diſcovery of the Admirable Rarefaction of the Air, even without Heat.

FROM what hath been deliver'd amongſt our new *Phyſico-Mechanical* Experiments, it appears, that long ſince I could, by the help of my Engin, rarifie the Air to 152 times it's uſual Dimenſions; and the *Virtuoſi* of the *Florentine* Academy tell us, that they would rarifie it, without the help of my Engin to 173 times it's former Dimenſions; Yet for further Satisfaction, I made the following Tryals.

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EXPERIMENT I.

Air expanded to about 8000 times it's natural Dimensions.

HAving fill'd a round Glaſs Egg of clear Metal, and furniſh'd with a Pipe ſome Inches long, with Water; this, together with a Viol, in which Water was likewiſe contain'd, was conveigh'd into a Receiver; and when the Air was exhauſted, we obſerv'd, that Bubbles were afforded plentifully in both, ſo that the Water ſeem'd to boil, and that in the Stem of the Glaſs Egg ran over. This being done, and the Water in both freed from Air, we took them out, and filling up the Stem of the Glaſs Egg, with Water out of the Bottle, we inverted it into more of the ſame; ſo that the Glaſs Egg and Stem was wholly full, except that a Bubble of Air was contain'd in the Top of the Egg, whoſe Dimenſions were a Tenth and leſs than two Centeſms of an Inch. Then the Glaſſes being placed in the Receiver, we ſet the Engin on Work; and obſerv'd, that the Bubble gradually expanded, till it fill'd up the whole Capacity of the Egg, except the Stem; and leſt the Water ſhould be thought to ſubſide only for want of the Internal Air to bear it up, we contin'd pumping, till the Bubble in the Egg expanding further, depreſs'd the Surface of the Water in the Stem, below the Surface of the External Water. The Air being thus far rariſi'd, we compar'd the Diameter of the Bubble with the Diameter of the Glaſs, and found it to be as 1 to 20; and conſequently, according to *Euclid*, the Proportion betwixt Spheres being triplicate to that of their Di-

Diameters, the Diameter of the leſſer being one, the Diameter of the other muſt be 8000. So that the Air expanded, poſſeſs'd 8000 times the Space it poſſeſs'd before. The Glaſs Egg being fill'd with ſuch Water again, and no Air included in it, tho' the Receiver was in a great meaſure exhauſted, yet the Water did not ſubſide, till a Bubble at the laſt roſe to the Top, whoſe Diameter was to the Diameter of the Glaſs as 1 to 14, ſo that according to *Euclid*'s Rule before-mention'd, the Bubble expanded, poſſeſs'd 2744 times as much Space as before. But Dr. *Wallis*, obſerving the great Thinneſs of the Glaſs, thought that the expanded Bubble poſſeſſed 8232 times it's former Dimenſions.

N. B. Water being let into the Exhauſted Receiver, till it would receive no more; we found, that by reaſon of ſome Leaks, the Receiver had not been perfectly exhauſted.

EXPERIMENT II.

June 2. 62.

A Small Bolt-head, which was able to contain 80 Grains of Water, being inverted into a Jar, it was ſhut up in the Receiver; and when the Air was exhauſted, Bubbles which roſe out of the Water expanding themſelves, preſently drove all the Water out of the Bolt-head; but when the Air was let in again, the expanded Air in the Bolt-head form'd a Bubble no bigger than a Pin's Head: After this, we fill'd the Bolt-head with Water clear'd of Air, and when the Receiver was pretty well exhauſted, a Bubble aſcended to the Top of the Bolt-head,

Air expanded to 10000 times it's former Bulk.

head, which, when the Air was again let in, was almoſt inviſible; yet the Receiver being again exhauſted, it expanded it ſelf ſo far as almoſt to drive all the Water out of the Bolt-head; yet when the External Air was again admitted into the Receiver, it ſhrunk into a Bubble, whoſe Diameter was $\frac{1}{33}$ part of the Diameter of the Bolt-head, ſo that to fill the whole Cavity it expanded it ſelf 10648 times; but conſidering the Cavity of the Neck of the Veſſel, which it likewiſe in ſome meaſure fill'd, it was expanded to 13769 times its Bulk.

The Diameter of the ſmall Bubble retracted, was $\frac{1}{21}$ of an Inch. The Diameter of the outſide of the Head of the Glaſs was $\frac{1}{33}$ of an Inch. The Water that fill'd the Head was $60\frac{1}{2}$ Grains. The Water that fill'd ſo far of the Neck, as the expanded Bubble poſſeſs'd was $17\frac{1}{2}$ Grains. The Bolt-head weigh'd 15 Grains.

EXPERIMENT III.

THE foregoing Experiment being repeated, we found that a Bubble, whoſe Diameter was $\frac{1}{11}$ of an Inch in Diameter, when expanded, poſſeſſed the whole Space of the Ball, as well as Neck of the Bolt-head, and depreſs'd the Surface of the Water within the Pipe, below the Surface of the ſtagnant Water.

From theſe Experiments it appears, that according to the moſt moderate Eſtimate, Air expanded will poſſeſs 2744 times it's natural Space, and according to our moſt ſucceſsful Ex-

Experiments 13000. So that we may justly admire the Minuteness of those Aerial Instruments, that she employs even about Visible Operations.

CHAP. XI.

New Observations about the Duration of the Spring of Expanded Air.

Observations about the Duration of the Air's Spring.

IT having not been as yet attempted to shew, whether a Portion of expanded Air, would retain it's Elasticity, and it's Power of Restitution or not, nor how long; nor whether a Portion of Air inclos'd in a Receiver, would have it's Spring vary'd upon Full, or the Change of the Moon; tho' I cannot much boast of the Progress I have made, yet I shall subjoyn the following Attempts on that Occasion.

A Glass Bubble newly blown, and whilst it contain'd none but rarifi'd Air, had it's Stem imediately clapt into a Flame, and Seal'd up; Many Months after it was inverted into a Basin of Water, and the Seal broke off under the Surface of it; and tho' Water was violently impell'd into the Cavity of it, yet the included Air had so far retain'd it's Spring, as not to suffer the Cavity to be quite filled with Water.

Another Method I took to shew the Durableness of the Air's Spring was the following, *viz.* Leaving a small Portion of Air in the Folds of

of a Lamb's Bladder, whoſe Neck was cloſely ty'd; it was inclos'd in another Veſſel, and conveigh'd into our Pneumatick Engin, and when the Receiver was exhauſted, the expanded Air diſtended the Bladder, ſo that it fill'd the whole Cavity of the Veſſel, by whoſe ſides, it was guarded from the Preſſure of the outward Air, ſo that the expanded Air kept the Bladder diſtended two Years.

For further Satisfaction, I contriv'd an Inſtrument, by which I could learn, whether, and how long Air variouſly expanded will retain it's Spring; by which I could not diſcover, that the Air loſt any thing conſiderable of it's Spring, in ten Weeks time.

Another Inſtrument I made uſe of, by which I could find, that Air expanded to 1000 times it's uſual Dimenſions, would be ſenſibly affected by Heat, and loſe the Expanſion it gain'd thereby, upon a Removal of that Heat.

March 18. We try'd the following Experiment. A Cylindrical Glaſs having a long Stem at the unſeal'd End, was fill'd with Water, and inverted into Water, which lay in the bottom of a large Pipe, ſeal'd at one End, and 3 or 4 Foot long; which being done, the large Pipe was ſo far exhauſted, that the Air the inverted Pipe poſſeſs'd the whole Cavity of it down to the Stem; upon which the larger Tube being clos'd up, the expanded Air poſſeſs'd the ſame Space 3 Months after, except that betwixt the Pipe and the Stem, upon extream Cold, the Water roſe ¼ or near ⅓. The clos'd *Apex* being broke open under Water, it gradually fill'd the whole Cavity, except a ſmall

Space

Space poſſeſs'd by a little Bubble. The Diameter of the Cylindrical Part of the Pipe was $\frac{1}{8}$ of an Inch, and its Length 3 Inches; the Bubble was about $\frac{3}{10}$ in Diameter, and $\frac{1}{100}$ in Depth; ſo that the Bubble was, according to *Dr Wallis* his Computation, to the Space it poſſeſſed, when expanded, as 1 to 1350.

CHAP. XII.

New Experiments touching the Condenſation of the Air by mere Cold, and it's Compreſſion without Mechanichal Engins.

Of the Air's Condenſation by Cold, &c.

TO try how far the Air is capable of being condens'd by mere Cold, when the Seaſon of the Year hath not pre-affected it; I try'd the following Experiment in *Autumn*.

In the middle of *September* about Noon, on a Sun-ſhiny Day, we placed a Bolt head in a Frame, ſo that the Stem was Perpendicular to the Horizon, and the lower End of it immers'd in Water. This done, we cover'd the Ball of the Bolt-head with a Mixture of beaten Ice and *Bay-Salt*; upon which, the internal Air being condens'd, the Water roſe up into the Stem, and ſtood a good while: Then having made a Mark at it's higheſt Station, we fill'd the Veſſel with Water, and found that it yielded ℥ iv and ℥ vj, the Weight of the Water which fill'd the Stem up to the Mark being ℥ j and ℥ iij, by which

which Number, the former being divided, the Quotient was 141 Drachms; ſo that the Proportion of the two Quantities being as, 11 to 1. The Space into which the Air was condens'd was, to it's former Space, as 147 to 158: ſo that the higheſt Degree of Condenſation it was then capable of, made it loſe of it's former Extent $\frac{11}{158}$.

N. B. Firſt, The Stem of the Glaſs ought to be long, leſt the Water, upon the Air's Condenſation, ſhould riſe into the Ball of it.

Secondly, The Cylinder of Water was two Foot, ſo that it might, by it's Weight, in ſome meaſure, hinder the Aſcent of more, and ſo keep the Air from condenſing to it's utmoſt.

Thirdly, When the Water roſe as high as it well could, we obſerv'd it to riſe and fall alternately, for a little time.

Fourthly, The Air may thus be further condens'd, than by Winters Cold.

But to ſhew that in the forgoing Experiment, the Cold did not compreſs the Air immediately, but partly, in as much as it, by ſtuffing up the Pores of the Water, caus'd it to ſwell, and ſo to compreſs the Air; I took a new Glaſs Bolt-head with a ſhort Neck, and fill'd it full of Water; ſo that when it was hermetically ſeal'd up, the Liquor wrought within 3 Inches of the Top, the ſharp End which was made for the Conveniency of ſealing being ¼ of an Inch long; This being done, the Bolt-head was plac'd in a Mixture of Snow and Salt, upon which, the Water aſcended and compreſs'd the Air into the Conical Part; upon which, the Glaſs flew in pieces.

In

which Experiment, according to Dr. *Wallis*'s Estimate, the Air was compress'd into a 4000th part of the Space it possess'd before. Which is considerable above the utmost Compressure made in Wind-Guns, where it is usually thought not to be compress'd into less than a 15th, and (according to *Mersennus*) into an 8th part of it's former Space.

CHAP. XI.

Of the Admirably differing Extension of the same Quantity of Air rarified and compress'd.

THE first Thing I shall take notice of concerning the different Degrees of the Air's Rarefaction and Condensation, is, That, in our Climate, tho' Cold will not condense it near into a 4000th part of the Space it possess'd before, yet it may be expanded to 70 times that Space. *The admirable different Extensions of the same Quantity of Air.*

Secondly, The Air may be much more condens'd and rarifi'd by our Engins, than by Heat or Cold; the Proportion in respect of Expansion being as 1 to 70.

But, *Thirdly*, Perhaps the Proportion betwixt the Degrees of the Air's Condensation and Rarefaction will not be thought so great, as what we have mention'd; if we consider, that the Air we make Experiments with here below, is so much compress'd already, by the Incumbent

Atmosphere, that for that Reason it is more inclin'd by it's Spring to yeild to an Expansive, than a Compressive Force.

Fourthly, It may be question'd, how the parts of the Air, which have a specifick Gravity, come to be spread so thin in the Cavity of the exhausted Receiver, since there is nothing in it for them to swim in, and to bear them up; Since the Proportion is so great betwixt the Parts of the Air, and the Cavity of the Receiver, they are contain'd in.

Fifthly, It is not a little wonderful, that Air should be so subject to vary it's Dimensions; so that if we consider how far it may be expanded without the Assistance of Art, elaborate Engins or Heat, the Top of the *Atmosphere* must be extremely rare.

To conclude; If we compare the utmost Degrees of Condensation and Rarefaction together, the same Portion of Air may possess 30000 times the Space, at one time, that it did at another.

CHAP.

CHAP. XII.

New Experiments about the weakned Spring, and unheeded Effects of the Air, communicated in the Philos. Transact. of Decemb. 75.

TO try whether, as some Corrosions of Bodies in close Vessels increase the Spring of the Air, so others may not weaken it; and likewise to discover whether some Effects of the Air may not depend on some unheeded Qualities, I made the following Experiments, which I shall lay down when I shall have made some Tryals. the Changes of Colour in Solutions of Copper, by the Influence of the Air.

EXPERIMENT I.

FILINGS of crude Copper being put into a Crystal Glass of a Conical Figure, with as much Spirit of Salt, as stood a Fingers breadth above the Filings; we cover'd the Vessel with a Stopple exactly adapted to it; upon a Solution of the Copper, the Colour of the Liquor was a dark Brown; but it soon lost that Colour, and was clear again like common Water; but when, by taking out the Stopple, the Liquor was again expos'd to the Air, it first acquir'd a brown Colour upon the Top, and that penetrating deeper into the Liquor by degrees,

Changes of Colour in a Solution of Copper.

grees; it, in a quarter of an hour, was wholly tinged with a brown Colour again; and so it successively laid down, and re-acquir'd that Colour, as it was stopp'd up, or expos'd to the Air, till at the last, being kept up a Month, it kept the brown Colour it had acquir'd in the Air unalter'd.

EXPERIMENT II.

A Bottle of the same Liquor with the former, and which was much clearer, being expos'd to the open Air, in half an hours time was not in the least alter'd; but the Vessel being again clos'd up for two or three hours, it acquir'd a faint Green; and the Glass being again unstopp'd 24 hours, the Green was deep enough, but not very transparent.

EXPERIMENT III.

ABout 3 Spoonful of the brown Tincture of Copper, was shut up in a Receiver, capable of holding ten times as much; It retain'd it's Colour half a Year in *Vacuo*, and then being expos'd to the Air, it acquir'd a Green in about an hour, without the Precipitation of any muddy Sediment.

EXPERIMENT IV.

SOme of the aforemention'd Tincture being left a considerable time in a Window, lost it's Colour, and appear'd like common Water; but towards the latter end of *December*, being expos'd to the Air, it acquir'd a faint and moderately transparent Green.

EX-

EXPERIMENT V.

FILINGS of Copper, and as much rectified Spirit of fermented Urine, as rose an Inch above them; being shut up in a Conical Glass with a mercurial Gage, in some hours the Mercury in the seal'd Leg was depress'd. *Filings of Copper and Spirit of Wine.*

EXPERIMENT VI.

A Gage being shut up in a Receiver, with the same Ingredients as in the former Experiment; In some time the Spirit acquir'd a very pleasant blew Colour, and two or three Days after, that Colour began to grow fainter and fainter; so that at the end of the fourth Day, it had wholly lost it's Colour: But being expos'd to the Air, in four or five Minutes the Top of the Liquor began to turn Blew, and at the end of ten Minutes, it diffus'd it self throughout the Whole, and five Minutes after, grew so strong, as almost to be Opacous. The Liquor shut up again, in two or three days time grew clear. And this Experiment being try'd several times, had the like Success. In trying these Experiments, I forbore to shake the Glass, lest the Alterations should be suppos'd to arise from any Sediment rais'd and mix'd with the Liquor, tho' for the most part, none was to be perceiv'd.

EXPERIMENT VII.

Filings of Copper with Spirit of Sal Armon.

HAving enclos'd Filings of Copper with Spirit of *Sal Armoniack*, enough to cover them an Inch, we shut up, with them, a Gage; In some time, the Spirit had got a blew Colour, and in the mean time, for two or three Days the Mercury in the seal'd Leg descended near ½ of an Inch. The like Success we had, when the Experiment was try'd several times after.

EXPERIMENT VIII.

Coral and Spirit of Vinegar.

A Mercurial Gage with Coral and Spirit of Vinegar, being enclos'd in a Conical Glass, whilst the *Menstruum* work'd on the Coral, several Bubbles were produc'd, which breaking in the Cavity of the Vessel, compress'd the Air into ½ parts of the Space it possess'd before; but after the Operation of the *Menstruum* was ended, the Compression declin'd, till the compress'd Air regain'd it's Extent within a third of what it was dispossess'd of by the Compression.

Spirit of Vinegar and Minium.

Spirit of Vinegar and *Minium*, being after the like manner enclos'd with a Gage in a Conical Glass, tho' the *Minium* was in a great measure dissolv'd, yet the Gage, discover'd no Alteration in the Air.

EX-

EXPERIMENT IX.

Filings of Copper with Sp. of Sal Armon.

ABOUT the 20th of *August* we put Filings of Copper into a Viol, with as much Spirit of *Sal Armon.* as cover'd them an Inch; In three Days it had acquir'd a deep blew Colour, and almost lost it again: The Viol being open'd, in five Minutes it was of a deep Blew; but being shut up again nine Days, it lost it's Colour.

EXPERIMENT X.

THE same Ingredients being shut up in a Viol hermetically seal'd, presently acquir'd a deep Blew, and in twelve Days after lost it again; during which time, the Mercury in the open Leg was impell'd up; but, when in the Night the Seal was broken open, there succeeded a Noise, and the Mercury in the shorter Leg was rais'd briskly near ½ of an Inch; and tho' the Air had access to the Liquor, at an Orifice no larger than a Pea; yet, in a Minute and a half, the Surface of the Liquor had acquir'd a lovely fair Colour a quarter of an Inch deep; and in five Minutes, the whole was Blew.

EXPERIMENT VII.

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HAving enclos'd Filings of Copper with Spirit of *Sal Armoniack*, enough to cover them an Inch, we shut up, with them, a Gage; In some time, the Spirit had got a blew Colour, and in the mean time, for two or three Days the Mercury in the seal'd Leg descended near ¼ of an Inch. The like Success we had, when the Experiment was try'd several times after.

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A Mercurial Gage with Coral and Spirit of Vinegar, being enclos'd in a Conical Glass, whilst the *Menstruum* work'd on the Coral, several Bubbles were produc'd, which breaking in the Cavity of the Vessel, compress'd the Air into ¼ parts of the Space it possess'd before; but after the Operation of the *Menstruum* was ended, the Compression declin'd, till the compress'd Air regain'd it's Extent within a third of what it was dispossess'd of by the Compression.

Spirit of Vinegar and Minium.

Spirit of Vinegar and *Minium*, being after the like manner enclos'd with a Gage in a Conical Glass, tho' the *Minium* was in a great measure dissolv'd, yet the Gage, discover'd no Alteration in the Air.

EXPERIMENT IX.

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ABOUT the 20*th* of *August* we put Filings of Copper into a Viol, with as much Spirit of *Sal Armon.* as cover'd them an Inch; In three Days it had acquir'd a deep blew Colour, and almoſt loſt it again: The Viol being open'd, in five Minutes it was of a deep Blew; but being ſhut up again nine Days, it loſt it's Colour.

EXPERIMENT X.

THE ſame Ingredients being ſhut up in a Viol hermetically ſeal'd, preſently acquir'd a deep Blew, and in twelve Days after loſt it again; during which time, the Mercury in the open Leg was impell'd up; but, when in the Night the Seal was broken open, there ſucceeded a Noiſe, and the Mercury in the ſhorter Leg was rais'd briskly near ½ of an Inch; and tho' the Air had acceſs to the Liquor, at an Orifice no larger than a Pea; yet, in a Minute and a half, the Surface of the Liquor had acquir'd a lovely fair Colour a quarter of an Inch deep; and in five Minutes, the whole was Blew.

CHAP. XIII.

A Statical Hygroscope propos'd to the Secretary of the Royal Society.

COnsidering how much Men's Bodies are influenc'd, by the Moisture of the Air and it's Dryness, I made use of the following Hygroscope to discover the different Degrees of those Qualities, *viz.* A Spunge; which is a Body that sucks up the Air's Moisture much more commodiously than several other Bodies; for tho' common Sea-Salt or Salt of *Tartar* will imbibe the Moisture of the Air, yet it is a hard matter to separate it from them again. And tho' Lute-Strings discover'd the Degrees of the Air's Moisture by the increase of their Bulk, yet they continu'd not to answer Expectation long. I likewise made use of a Cup, made of a Light Wood, with a Button on the Bottom of it, to which a Hair being ty'd, it was, by that, suspended at a Ballance; and also, I observ'd several things, when I made use of Sheep's Leather, which would be a good Hygroscope, being plentifully furnish'd with Pores to imbibe Moisture, but that it is more subject to Rot than Spunge.

A Statical Hygroscope.

For in the main, I found nothing so convenient as Spunge, which is so plentifully stock'd with Pores, that a Drachm, having imbib'd as much Water as it could contain without dropping, weigh'd 2 Ounces and 2 Drachms; And

All

All that is requir'd in using this Hygroscope, is, that the piece of Spunge made use of, be first weigh'd in Air of a moderate Temperature, with a Nice Ballance; for as afterwards it increases or decreases in Weight, so accordinly the Air is moister or drier. In making use of this statical Hygroscope, you may use what Quantity of Spunge you please, so that it's Weight be not so great as to injure the Ballance.

CHAP. XIV.

A Brief Account of the Utilities of Hygroscopes.

The Usefulness of Hygroscopes.

THE Use of a Hygroscope is either General, or Particular; The general Use is, *to estimate the Changes of the Air, as to Moisture and Dryness, by ways of measuring them, easie to be known, provided and communicated.* This appears from the Description of our statical Hygroscope; by which, we can by the help of small Weights, discover the least sensible Alterations in the Temperature of the Air; nor is it the only Advantage in our Hygroscope, that it is able to discover such Alterations in the Air's Temper, but it is an Additional one, that it is durable and lasting.

N. B. It is one great thing wanting in the Preparation of Hygroscopes, that we have not yet found a Standard of Moisture and Dryness to adjust and compare other Hygroscopes by.

But

But having thus briefly intimated the most general Use of Hygroscopes, I shall now proceed to mention their Particular Uses.

USE I.

To know the differing Variations of Weather in the same Month, Day and Hour.

I Have commonly observ'd, that when the Weather was at a stand, the Spunge grew heavier in the Night, but lost that Moisture the next Day, before Noon; but in frosty Nights, at the latter End of the Winter, this Observation did not hold.

Amongst other Observations, it would not be amiss to note, whether there be any Correspondence in the Air's Operation on Hygroscopes and Baroscopes; and if at all, in what kind of Weather. For usually in the Summer, when the Hygroscope is lightest, the Baroscope is higher, tho' strong Winds may make both lighter, such as the *North-West* with us; whereas *South* Winds with Rain usually make the Baroscope lighter, and the Spunge heavier. And *East* Winds, tho' they make the Baroscope heavier in Winter, yet they make the Hygroscope lighter.

It would likewise be of use to observe on the Sea-Coast, whether the Ebbing and Flowing of the Sea, causes any sensible Alteration in the Hygroscope, as likewise at what time the Air is moistest; especially at Full and New Moons; by which Observations we may more easily hope to determine, whether the Moon diffuses

diffuſes a Moiſture through the Air or not, than by obſerving the Plumpneſs of Oyſters and Shell-Fiſh, or of the Brains or Marrow of Animals, which is a hard thing to be ſure of. To theſe Obſervations it will be requiſite to note, whether upon Spring-Tides in *March* or *September*, the Hygroſcope receives any ſenſible Alteration.

USE II.

To know how much one Year or Seaſon is dryer or moiſter than another.

IF the Hygroſcope when it continues longeſt without ſome ſenſible Alteration, be taken for a Standard; by comparing Obſervations made at other Seaſons of the Year, and in other Years, it will be eaſie to learn how much one Year is moiſter than another. How much theſe Obſervations may be of Uſe to Phyſicians, where Diſtempers ariſe from too much Moiſture or Dryneſs, and to Husband-Men and Shepherds in ordering their Corn, and removing their Flocks, from too moiſt Ground, I ſhall leave undetermin'd. But in order to make Predictions, it will be neceſſary to Regiſter the Number, Bigneſs and Duration of the more conſiderable Spots, that appear or are diſſipat'd near the Sun; and what Alterations happen to the Hygroſcope at ſuch times. Nor would it be amiſs, to obſerve what Alterations happen upon Eclipſes of the Sun and Moon, or great Conjunctions of the Planets. *Uſe 2.*

USE

USE III.

To diſcover and compare the Changes of the Temperature of the Air made by Winds ſtrong or weak; froſty, ſnowy and other Weather.

Uſe 3. THAT the Spunge in the Wind or Sun loſes conſiderably of it's Weight, I my ſelf have experienc'd, a Spunge hanging in the Sun in *January*, having loſt a 24*th* Part of it's Weight, after it had been 3 quarters of an hour expos'd to it; and making uſe of half an Ounce of Sheeps Leather inſtead of Spunge, this being hung in the Wind, only loſt $\frac{1}{32}$ of it's Weight in an hour.

But tho' it be poſſible thus to make Obſervations of Particular Winds; yet it requires a great deal of Caution, as well as Skill in Phyſick and Coſmography, in forming Rules for the obſerving of the Qualities of other Bodies, ſince Winds which come from the ſame Quarters in ſeveral Countries have different Qualities; for tho' *North* Winds in the Winter, are generally attended with Froſt, yet at the Famous Port of *Archangel* a Thaw accompany'd it; the Reaſon of which ſeems to be no other than, that the *Northern* Wind coming a long way over the *Northern* Seas, does not acquire ſuch a Diſpoſition as the *South* Wind, which paſſes over a large Tract of Frozen Land. And it is obſerv'd in *Ægypt*, that the *North* Winds which are elſewhere drying, are there moiſt, which is atteſted by Mr. *Sands* in his Travels into *Ægypt*, *lib. 6. Cap.* 8. *Sect.* 3. And Monſieur *de Serres* affirms, that

that about the Quarters of *Tholouze*, the *South* Wind dries, and the *North* Wind brings Rain; yet from *Narbonne* to *Lyons*, all over *Provence* and *Dauphine* it is quite otherwise.

But, besides that on this account Winds from the same Quarters may differently affect the Hygroscope; It's Operation may be considerably diversify'd, as it blows vehemently or slowly over the same Country; for tho Wind would rather increase the Weight of a Hygroscope if mov'd slowly, yet by a more vehement Agitation, several moist Particles in the Spunge are dissipated and dispersed. To these Observations I shall add the following, *Viz.* that frosty Weather hath been observ'd to make the Hygroscope grow lighter towards Night, and that snowy Weather increas'd the Weight of it, as likewise misty and foggy Weather.

But what is more strange is, that on a Sunshiny day, the Spunge hath preponderated upon the passing by of a Cloud; but as soon as that was gone, regain'd it's *Æquilibrium*; and I have observ'd, that when the Air hath grown heavier, the Hygroscope hath grown lighter, as if those Terrestrial *Effluvia* which increase the Weight of the Air were unfit to be imbib'd into the Pores of the Spunge; wherefore at such times it may not be amiss to take notice; whether any, and if any, what Kind of Meteor, as Wind, or Rain or Hail, or in the Winter, Snow or Frost, will commonly be signify'd or produc'd.

USE

USE IV.

To compare the Temperature of differing Houses, and differing Rooms in the same House.

Use 4. THIS may be of considerable Service in enabling Men to choose Rooms, which may be most consistent with their Health; for the difference in some Rooms hath been observ'd to be so considerable, that a Drachm of Spunge hath acquir'd the Additional Weight of 3 Grains and ½, and upon a removal into another, hath lost 1 Grain and ½, tho' in a rainy Night. And a piece of Spunge that wanted 4 Grains and ½, being remov'd into another Room near a Fire, in a short time, wanted but 1½ Grain, and the next Evening after this Observation was made, it weigh'd 3½ 1 Grain and almost a half: The next day it exceeded a Drachm above 2 Grains, but about 4 in the Afternoon the Weather growing frosty, it lost of it's Weight; and a Drachm of Spunge that was kept in a dry Room upon foggy Weather, being remov'd, in a Nights time, gain'd 11 Grains, and in the Morning being remov'd into the former, it gain'd 2 Grains.

USE V.

Use 5. TO *observe, in a Chamber, the Effects of the Presence or Absence of a Fire in a Chimney or Stove*; which will sensibly appear by the help of our Hygroscope.

USE

USE VI.

To keep a Chamber at the same Degree, or an assigned Degree of Dryness.

THIS may easily be done by observing the *Æquilibrium* of the Spunge, and accordingly increasing or diminishing the Fire. I have observ'd a notable Difference in the Weight of a Hygroscope, when the Room hath been wash'd, tho a good Fire was kept in it to dry it presently. *Use 6.*

To these Observations I shall add, that I have sometimes taken notice, that the Hygroscope hath not answer'd our Expectation, as at other times; whether the Air, at that, abounded with other *Effluviums*, which render'd the moist Particles of it, more unfit to be imbib'd by the Pores of the Spunge, I shall not determine; nor whether in time Hygroscopes may not help us to discover the Nature of different *Effluviums*, such as those of Spirit of Wine, Chymical Oyls, &c. Nor shall I undertake to determine, whether this Instrument joyn'd with the Baroscope and some others, may not help to give us a foresight of some Constitutions of the Air which precede Diseases, Hurricanes, Earthquakes, or Inundation; especially of those Accidents which depend on the Air's being overcharg'd with Exhalations and other moist Vapours; as well as it does of a shower of Rain.

To conclude this Chapter, I shall intimate, that tho' in these Matters it be perhaps impossible to form *Hypotheses*, which can in no Points

be

be call'd in Question, yet the Theory may be as good as can, by a wise Man, be expected, in so mutable a Subject as the Air; and therefore they ought not to be slighted or suddenly laid aside, since several Accidents may intervene in the Air, on which those may depend. As we know, tho' Tides generally Ebb and Flow, so as to answer the Theory given of them, yet by fierce Winds and great Land-Floods, the regular Course of them hath often been alter'd.

CHAP. XVIII.

A new Experiment and other Instances of the Efficacy of the Air's Moisture.

The Efficacy of the Air's Moisture.

THAT the Moisture of the Air hath had considerable Effects on Subjects far less tender and curiously contriv'd, than Men's Bodies, will appear from what follows; and that the Moisture of the Air hath a considerable Influence, and usually a bad one, may well be argu'd from the Effects we have taken notice of on several Parts of Animals; and that the Skins of Animals are sufficiently prepar'd to receive such *Effluvia*, appears from what I have before observ'd, viz. That Sheep's Leather being made use of for a Hygroscope, plentifully imbib'd the Moisture of the Air; and even Bladders which by Nature are made impervious to Urine, are so dispos'd to imbibe the Moisture of the Air, that the membranous Part put into a

Pair

Pair of Scales, and counterpois'd, makes a good Hygroscope; and not only these, but Lute-strings, which are made of the twisted Guts of Animals, and even Bones, the most solid Parts of Human Bodies, will so far imbibe the Moisture of the Air, as to swell considerably.

Nor are Animal Bodies alone capable of having their Pores penetrated by the Moisture of the Air; but it insinuates it self into inanimate Bodies, and swells the solid Parts of Wood; and even Polish'd Marbles are observ'd to be so plentifully stock'd with moist Vapours, as evidently to sweat; nay even the Air it self is not without Vapours and moist Parts, dispers'd through it in the Heat of Summer, which will appear from the following Experiment.

Having fill'd a Bottle with Water and four Ounces of *Sal Armon.* we counterpois'd it in a Pair of Scales, and in an Hours time, so many moist Particles in the Air were condens'd by this saline Mixture, that they first appear'd in the form of a Dew, on the outside of the Glass, and then ran down the sides of the Vessel, till the Scale preponderated and weigh'd a Drachm more than the other.

But to proceed to Instances, which shew the Force and Efficacy of moist Vapours, when they penetrate solid Bodies. It is no weak Argument of their Efficacy that we observe, that, by the powerful Insinuation of Moisture, the Strings of Musical Instruments are swollen and broken; nor is it inconsiderable, that Doors and Door-Cases are so swollen in Rainy Weather, as to open and shut with a great deal of uneasiness.

Wooden Pipes swell by the Air's Moisture.

Besides which Instances, I have observ'd a Piece of Wood to encrease considerably in it's Weight in rainy Weather: And I am told, it's usual for musical Instruments to grow out of Tune, not only the Wooden, but the Metalline Pipes of Organs being apt to swell in wet Weather. And not only by the help of Rain, but the Moisture of the Air, Marchasites have been swollen and burst asunder; which I am apter to believe, because I have observ'd Vitriolate Efflorescences upon the Surfaces of shining Marchasites, caus'd by the Action of external Moisture on them; and the Moisture of the Air hath so powerfully penetrated some Marchasitical Substances, that they have burst asunder; whereupon it appear'd, that a greater Quantity of Vitriol was generated within their Substances, than without.

To conclude what I have to say on this Subject, I shall add the following Experiment to assist a *Virtuoso*, to make an Estimate in known Measures, of the mechanical Force of the Aerial Moisture.

I caus'd a Rope about 22 Yards long, to be fasten'd at a convenient Height, to an immoveable Body; and then having fix'd a Pully to another stable Body, about 18 Yards distant from the former, the Rope lying upon the Pully, was, betwixt both, almost in an horizontal Posture; but to that End of the Rope, which hung down from the Pully towards the Ground, was fix'd a Weight of 50 Pound, and to the upper Part of that, an *Index*, which being plac'd horizontally, pointed to a Board which was divided into Inches and parts of Inches, that we might discover

discover the better the Ascent and Descent of it upon changes of Weather.

When the Weight had stretch'd the Rope as much as it could; I observ'd, that in one rainy Night the Weight was rais'd five Inches; but the next Day proving a dry Day, it was depress'd lower than before.

But a heavier Weight being made use of instead of the former; *June* 4th in an hour and quarter, the hundred Weight was rais'd ½ of an Inch. The Sky being cloudy, but without Rain. *June* 6th. In the Night which was cloudy, it was rais'd about 3 Inches, and an hour after that Observation was made, it rose half an Inch more.

From whence it appears, that the Force of the Air's Moisture is considerable, since the Rope that, by it's Assistance, rais'd the Weight, was but about the third Part of an Inch Diameter, being $\frac{1}{3}$ and 4 decimal Parts of $\frac{1}{10}$.

CHAP XIX.

Of some unheeded Causes of the Insalubrity and Salubrity of the Air, &c.

The Insalubrity and Salubrity of the Air depends on subterraneal Vapours.

Amongst the several Causes, on which the Salubrity and Insalubrity of the Air depend, subterraneal *Effluvia* are in Effect most considerable; which differ not only according to their respective Natures, but according to *Place* and *Time*; according to *Place*, as they ascend from the superficial or deeper Parts of

the *Terraqueous* Globe; according to *Time* such as ascend daily, and may be term'd ordinary Emissions, or only at distant times; the latter of which may be term'd periodical, and sometimes fortuitous or irregular.

But notwithstanding the Vapours which rise from the Earth, may be distinguish'd by these Distinctions; yet since Nature offers her *Phænomena* not so distinct, but confusedly and together, I shall sometimes consider the Terraqueous Steams, in the more general Notion, with reference to each of the Members of this Distinction. But that I may deliver what I have to say more distinctly, I shall lay it down in the following Propositions; having first observ'd, that the Insalubrity of Marish, and the Salubrity of Sandy Grounds, may depend on some *Effluvia*, which act not meerly or principally as they are *Moist* or *Dry*.

Proceed under the following Propositions.

PROPOSITION I.

Prop. 1. THE first Proposition is, That *it seems probable, that in divers places, the Salubrity or Insalubrity of the Air considered in general, may be in great part due to subterraneal Expirations, especially to those I call'd ordinary Emissions.* Which may contribute to the preserving of Health either by promoting Respiration, or by correcting noxious Particles in the Air, and checking morbifick Fermens.

And indeed, if we consider what a great variety of Bodies, besides Minerals, the Earth is stock'd with, tho' some may emit *Effluvia* noxious to Men as well as Plants, yet in that Varie-

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ty there may not be a few, whose Exhalations may be as friendly to him; for Trees and Grass have not only been observ'd to flourish over Tin Mines in the *West* of *England*, but over Veins of another kind of Mineral, which was not far from the Surface of the Earth. And it is observ'd, that those that Work in Tin Mines, usually live very long. And I have not only been told, that the Fumes that rise from such Mines, tho' often very bituminous, and of an offensive Smell, yet some of them are well scented: And a Friend of mine, who caus'd himself to be let down in a subterraneal Cavern, which was broken open by digging for a Mine, not only observ'd, that the Air was very pleasant to breath, but likewise amongst several imperfectly form'd Minerals, store of a Mineral Earth very fragrant and pleasant, which Smell it in some measure retain'd, when it had been expos'd to the Air for some time.

And I my self have observ'd in *Ireland*, a piece of Ground to yield very good, tho' short Grass, in a Country justly esteem'd healthful, which I attributed to some sulphureous Exhalations from Lime-stone; which have had so considerable Effects in other places, that I am told that a piece of Ground in *Derbyshire* which lies upon Lime-stone, is so warm'd by the Vapours that rise from it, that Snow is much sooner Thaw'd upon it, than that which lies near it, on Soil which covers Free-stone. To which it may be added, that a Gentleman observ'd in *Hungary*, that walking over some Ground which affords that Noble Ore call'd by the *Germans Rot-gulden ertz*, the Air was very pleasant, nor was the Air much

less pleasant on that Ground which lay upon Veins of *Cinnabar*; yet over other sorts of Mines the Air was very inoffensive. Nor is it improbable, that subjacent Fossiles should influence the Air, since I have observ'd Mineral Earths twenty Foot deep, yield a volatile saline Spirit, like that of Harts-horn.

And that several *Effluvia* may impregnate the Air, which are not to be discern'd by any of our Senses, appears from those Magnetical *Effluvia* of the Earth, discover'd by the Ingenious *Gilbert* and others, which do not only steam through the Air, but as I have observ'd, act upon Bodies in an Instant, which are contain'd in Glasses hermetically seal'd.

But tho' from hence it may appear, that the Salubrity of the Air may be improv'd by the *Effluvia* of some Minerals; yet it is beyond doubt, that in general they render the Air Insalubrious, since there are a great many more that emit bad, than good ones: For besides that the Air hath been observ'd in *Hungary* to be very offensive and prejudicial to Respiration, that in the *Neapolitan Grotta de Cani*, suddenly deprives Dogs both of Sense and Motion. To which may be added the *Averni* in *Hungary*, which suddenly kill those that draw in the Air infected with them. Besides which, there are a great many noxious *Effluvia* which rise from Marchasitical Minerals, which we take little notice of, and in places which we little suspect them to be in; nevertheless, they infect the Air, and render it corrosive, by emitting that ill condition'd Sulphur, which they so much abound with, that a pound distill'd in an Earthen Vessel with a good Fire,

besides

besides an inflammable Sulphur, which was condens'd into thin Films on the side of the Receiver, yielded a strong Acid, not much unlike *Gas Sulphuris*, which was corrosive enough to dissolve Coral in the Cold. And that there is other Marchasitical or Vitriolate Matter in *England*, besides those Stones, from which the greatest part of Vitriol is obtain'd, I my self am a Witness, who have obtain'd a Vitriol from a Vein of Metalline Oar, consisting of a black, heavy Stuff, without any troublesome or artificial Preparation.

PROPOSITION II.

It is probable, that in divers Places some Endemical Diseases do chiefly or partly depend on Subterraneal Steams. Prop. 2.

UNder the Title of Endemick Diseases, I not only comprize those that are solely peculiar to some Places, as the *Plica Polonica* to *Poland*, and the Disease in *France* call'd *le Colique de Poitou*, but those that chiefly appear in particular Countries, as Agues in *Kent* and *Essex* Hundreds, Consumptions in *England*, and Fluxes in *Ireland*.

But before I proceed further under this Topick, it is requisite I should first Advertise, that I deny not but that a great many of such Distempers may depend in a great measure on Excessive Heat or Cold, or some other manifest Qualities of the Air, as also bad Diet, or Intemperance; but the Reasons why I think they generally in a great measure likewise arise from

some noxious and contagious subterraneal *Effluvia*, are the following.

1. Because frequently the Causes are not manifest; and 2. Contagious *Effluvia* may be emitted. 3. A large Tract of Land may abound with the same kind of Mineral, and another piece of Land with another. 4. As the *Effluvia* are Saline, Sulphureous, Antimonial, Arsenical, or of another Nature, they may have different Effects; so in *Hungary*, some cause a difficulty of breathing.

But the *Effluvia* of the Earth, do not only affect the Body by the Mediation of Respiration, but being contiguous to the Skin, get in at the Pores of the Body, and have sensible Effects on the Internal Parts. And that the Pores of the Body are capable of receiving very subtle *Effluvia*, might be evinc'd by several Instances; but it may suffice to intimate, that I have so prepar'd a Mineral Substance, that it would have very sensible Effects on Substances contain'd in the Bladders of dead Animals, when it had no other way to get to those Substances than through the Pores of the Bladder, which are not near so perspirable as other Parts of the Body, not constituted to hold so subtle and penetrating a Liquor as Urine.

Nor need it be a less Wonder, how these subterraneal *Effluvia* should have so sudden Effects on human Bodies, and in so little time, since we see in moist Weather, how suddenly Lute-strings are broke, and Ropes shorten'd by the Insinuation of moist Particles into their Pores. And tho' those *Effluvia* are not so plentifully dispers'd in the Air, as to enter the Pores in such Swarms,

yet

yet the Maſs of Humors may in time be ſufficiently impregnated with thoſe noxious Vapours to enable them to produce their Effects, when, ſuck'd into the Capillary Veſſels, they gradually deprave the Maſs of Blood.

And that *Effluvia* from without, may have conſiderable Effects on the Maſs of Blood, appears from *Appenſa* and *Periapta*, as alſo the Effects of Mercurial Plaiſters and Girdles; and the *Effluvia* of a Load-ſtone, which caus'd a Friend of mine to be troubled with Fits of the Colick, an Argument that Mineral *Effluvia* may cauſe particular Diſeaſes. To which we may add, that Arſenical *Appenſa*, extoll'd by ſome in the Plague, have produc'd the Effects of Poyſon, and in ſome a Faintneſs and Diſpiritedneſs, according to the Teſtimony of ſeveral Phyſicians. And that Mineral Expirations may cauſe a determinate Diſtemper, we may learn from an Obſervation of mine, which was, That a Chymiſt rubbing very often Red Arſnick in a Mortar, and endeavouring to make an Excellent Medicine of it, firſt complain'd to me of a Difficulty of breathing, and ſometimes of Pains and Tumors in his Teſticles.

And it will not be very much doubted, whether Mineral *Effluvia* penetrate the Pores of the Body or not, by thoſe that ſhall know, that the Fumes of Sulphur are ſo penetrating, that at the *Pic of Teneriff*, they blacken Silver in the Pockets of thoſe that go up to it. I made a Preparation of Sulphur, which emitted *Effluvia* ſo powerful in the Cold, that they penetrated a Leathern Purſe, and diſcoloured Silver conceal'd in it.

But

But besides the forementioned Effects of Vapours on the *Pic* of *Tenriff*, I was told that one that ascended that Mountain, had the Colour of his Hair altered before he came down again; which argues the Power of Mineral *Effluvia* to penetrate the Pores of the Body.

But lest it should be questioned by some, whether such Mineral *Effluvia* would not be consumed, and cease in less time than Endemical Diseases are continued in one Place; I shall intimate that I think several subterraneal Bodies may have a power of propagating their Virtue to Matter contiguous to them, by some Seminal Principle, or something Analogous to a Ferment, or by bringing some more Crude Mineral Earths gradually and successively to a greater Degree of Maturity and Perfection: For it hath been observed, that in Tract of time a Mineral might be obtained from an Earth which at another time it could not be obtain'd from; which Observation holds as to Nitre, which is one of the most Catholick Fossils, and most plentifully emits *Effluvia*. Besides, tho' Mineral *Effluvia* in the Region of the Earth discoverable by us, should be consum'd; I see not why supplies may not be brought from the Bowels of the Earth. Indeed, considering how closely the Matter of Minerals is crowded together, and how long Magnets severed from their Mines, emit *Effluvia* without a sensible Diminution, the Stock of Mineral Earth from whence they flow cannot be thought suddenly to be exhausted; for an Effluviating power is so durable, that one had a perfumed Watch, which, tho' constantly worn, preserv'd it's Scent 16 years, and by the same Reason could

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perfume Marbles quite through, so that they retain'd their Scent a long time.

But before I leave this second Proposition, it is requisite that I should take Notice, that noxious *Effluvia* may cause Distempers, not only by Respiration and penetrating the Pores of our Body, but by impregnating the Water made use of for preparing and Diluting our Aliment, without any sensible alteration in the Water to be discern'd by us; So Water by an Infusion of *Crocus Metallorum* becomes Emetick; and indeed sometimes, these *Effluvia* are so numerous, that in the Borders of *Lancashire*, the Mud in a Ditch is so strongly impregnated with subterraneal Exhalations, that at the Surface of the Earth or Water they will take fire, and flame like a Candle.

But besides that Distempers may be propagated by these subtle *Effluvia* impregnating Water, they may be also prejudicial, in as much as being mixed with the Nutriment of Plants, they may deprave their Juices, and consequently make them unfit to be eaten: And that Mineral *Effluvia* may in a great measure deprave and influence the substances of Plants in their growth, is confirmed by some, who have noted, that Oaks, growing in Ground which abounded with Vitriolate Mines, were much more heavy and solid than others; and these *Effluvia* are sometimes so numerous and crouded into the Pores of Plants, as not to be overcome and concocted by the Ferments of the Plants, but to keep their own Natures; for I have observed in a Vine near *Paris* several Marchasitical Particles throughout the Pores of the Root and Trunk.

And

And I have been told that at *Tockay* in *Hungary* the very Kernels of the Grapes are as if it were Guilt over with Leaf Gold. But,

Besides the aforementioned Ways by which our Bodies may be affected with Noxious *Effluviums*, we may not a little suffer, by the deprav'd Humours which some Animals we Feed upon, are nourished by, and which vitiate their Bodies primarily, and secondarily ours.

As from what hath been said it, appears, that Subterraneal *Effluvia* may cause Distempers, so it may not be amiss to take Notice that possibly in some measure Mineral *Effluvia* may prevent Distempers; for 'tis Observed, that several parts of *Scotland* are free from Agues, and that very hot and large Regions in the *East-Indies* are rarely troubl'd with the Plague; nor is it less remarkable that in *Ireland* the Air is impregnated with such sort of Emanations as prevent the Generation of any venemous Creatures; To which I shall add the following Instance from *Beguinus* in his own words, who says, *Dignum admiratione est, quod quamvis in vicinia Hydriæ Comitatus Gloricensis, ubi reperitur copiosè & singulis fere annis Lues pestifera grassatur, illata tamen semper immunis ab hac manere soleat, ideo viri providæ ætatis se observasse, & a Majoribus suis accepisse mihi sæpiùs confirmarunt*; to which I shall add further that the Learned *Michael Magerus*, pronounces *Mercury* an Antidote against several Diseases; and particularly the Plague.

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PROPOSITION III.

It is likely, that divers Epidemical Diseases are in great Part produc'd by Subterraneal Effluvia. Proposition 3.

THo' several Epidemical Distempers are caused by manifest alterations in sensible Qualities of the Air; yet to shew that some of them principally, and others partly depend on the Effects of Subterraneal *Effluvia*, I shall offer the following Considerations.

And First, the Structure and disposition of the Parts of our Globe, which are not much below the Surface of it, and much more, the deeper Subterraneal Regions, are so plentifully stocked with Mineral substances; so, that it is not improbable but that Subterraneal *Effluvia* ascending thence into the Air, may cause excessive Heat or Cold, or some other manifest Qualities, and consequently in part occasion most Epidemical Diseases. For from what I have elsewhere shewn, it not only appears, that these *Effluvia*, by acting on one another may excite sudden heats; but also that Minerals, of different Degrees of Maturity, acting on one another, may produce an Intense Cold. Besides, the changes of the Air on which Epidemical Diseases depend, are so considerable, and instantaneous, that they can scarce be attributed to the Influence of the Sun or Moon, which are too regular and constant in their Influence to cause such Anomalous effects, as we cannot but take Notice of in a few years time; but

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are rather caused by an Irruption of Subterraneal Steams, which are frequently both impetuous and Irregular: And tho' some attribute them to the Influence of the Stars; yet the vanity of Judiciary Astrology having been so plainly detected by several Learned Men, I shall here only observe that it is much more unlikely that particular Towns should alone be Influenced by such, than by *Effluviums* from Bodies near the Surface of the Earth where those Places stand; and that which renders it much more probable is, that I have frequently known Diseases very Fatal to happen suddenly in some places, where the first Contagion hath been accompanied with a very troublesome Fog.

That sudden and violent Heats may be produc'd by a Mixture of Subterraneal Bodies, not only appears from Oil of Vitrol pour'd upon Iron, Spirit of Nitre upon Butter of Antimony, Filings of Copper, Tin, or crude Antimony; But from Oil of Vitriol poured upon Powdered Marchasites which was accompanied with very strong Scented Fumes: To which I shall add, that even Sulphur hath to my knowledge had considerable effects on Marchasites: And I have been told by a *German* Chymist, that in *Germany*, Marchasites which were found there, would grow hot, if long immers'd in pure Water. And if we consider upon how many Accidents the Course of Subterraneal Waters may be turned, it will be easily evident, upon that Account considerable Degrees of Heat may succeed; for if a convenient quantity of Filings of Steel be mixed with Powder of Sulphur, and that Mixture be moistened with Water, it presently

sently grows very hot, and emits Fumes copiously, like Slak'd-Lime.

And I have been inform'd by several, who frequent Mines, that Damps, which are made up of Subterraneal *Effluviums*, are not only very irregular in Reference to their Distance, but also their Duration; and have very ill effects on those that come within the reach of them; and if such pernicious Fumes are to be discover'd so near the Surface of the Earth, well may they affect those that Inhabit on the Soil, near which such *Effluvia* rise: I say *near which*, because tho' they do not immediately rise in the very Towns they infect, and are carried thither by the Motion of the Air; yet in a large Tract of Land, they may be so dispersed as to have no considerable Effects.

But it is not requisite always that those *Effluvia*, which cause Distempers, should be noxious at their first Rise from the Earth, since Mineral Fumes may acquire new Qualities by associating with particular Particles in the Air, and may by that means be disposed to act upon particular Parts of the Body, and to cause a determinate Disease: So tho' neither Spirit of Nitre nor Sal Armoniack alone can Dissolve Gold; yet *Aq. Regia*, which is a Composition of both, will; but hath no such effect on Silver, Diamond's or Rubies.

As for the Reason why Epidemick Distempers affect some and let others go free; it may not only be accounted for by the peculiar Dispositions of those Bodies, but also by considering, that the *Effluvia* which rise from the Earth, may be

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so imperfectly mixed with the Air, as to fall upon one Body, and not another; so I have observed several Leaves on a Tree blasted with a Wind which blew at that Corner of the Ground, yet others on the same piece of Ground were untouch'd; nay, the very Leaves of that were not all blasted on that side which the Wind blew, so that I suspected some Arsenical Vapours being mixed with the Air, cast upon them were like Hail shot from a Gun, and scattered in it's Flight: And on a Cause not much unlike this may depend the Effects of some Winds which cause Blasts on the Faces of some People, yet let others go free, as I remember I was Riding once in the Wind, which, tho' it disaffected not me, yet my Man, who Rid after me, scaped it not.

In favour of our Hypothesis already laid down, I shall add, that the short duration of some Distempers, as well as their Progressive Motion from one Town to another, are Arguments either that these Vapours rise all at once, and are dispersed, or the Subterraneal Commotion that causes them passes on from one Part of the Earth subjacent, to another. Nor is it less Consonant to our Hypothesis that the short duration of some Distempers may depend on a successive rise of *Effluvia*, since when those of one kind cease to be emitted, and another kind succeeds, the latter may check the former by precipitating them, or uniting into *Quid Tertium* less prejudicial to all Animal Bodies. So by an association of new Particles with those Pestilential *Effluvia* which cause an Annual Plague in *Grand Cairo*, it suddenly stops, and those already infected, dye not, if the Air be sufficient-

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ly impregnated before, as a late Writer of Voyages into *Ægypt* testifies in these Words. *The Drops or Dew purifies the Air; for as soon as it falls, the Plague ceases to be Mortal, none dyes of it; The Air is wholesome, all Distempers cease; and if any person grows sick, he never dyes,* &c. I have been told that about the *Tin Mines* in *Devonshire*, not only the Grass and Fern, but the Trees will be suddenly blasted, by the powerful *Effluvia* which suddenly rise over a considerable compass of Ground.

Having said thus much of *Epidemical* Distempers, it perhaps may be Expected that I should say something of the Plague and it's Origin, which I must own my self at a loss in; for tho' I think it rather seemingly Pious, than really so, to ascribe such things to a Supernatural Power, which may be accounted for by Natural ones; yet I deny not but that some may arise from a Supernatural Origin.

But what ever may be the first Origin of Plagues, I am inclined to think, that the Propagation of them depends on a Malignant Disposition in the Air, arising from some Subterraneal *Effluvia*; for these Reasons; First, because the Malevolent Aspects of the Planets seem too Remote and Indeterminate to act on a particular place. Besides, according to the Vulgar Hypotheses, the Plague ought to rage most where it very seldom happens: For *Leo Africanus* informs us, that in *Numidia*, tho' raging hot, it happens but once in an hundred Years; and *Purchas* in his *Pilgrimage*, Lib. 5. Cap. 13. tells us, it is not known at all in the Land of *Negra*, and seldom in *Japan* or *New-England*; and in the *East-Indies*, *China*, *Tunquin*,

and *Cochinchina*, it is never heard of: Whereas the Country of *China* contains more Inhabitants than all the Nations of *Europe*; and were the Plague a Puniſhment inflicted for the ſins of Men, certainly in Countries ſo large and ſavage, they might expect it from Divine Juſtice as often as we.

But perhaps it may be ſaid, that theſe Hiſtories as much Preſs our Hypotheſis, as thoſe others alledged by Phyſitians: But if we conſider, that I confeſs it difficult to determine the Original cauſe, the other part of my Hypotheſis is not at all ſhaken, ſince it could not be denyed, but that noxious *Effluvia* would be able to propagate the Plague there, were there an Original cauſe to ſet thoſe ſecondary cauſes on work: But for as much as from our Hypotheſis it appears that the Original Cauſe of the Plague is not always ſo abſtruſe, but ſometimes begun, as well as propagated by thoſe noxious *Effluvia*, without the Concurrence of any other Cauſe, it may be requiſite to take Notice, that in *China* and thoſe Countries where the Plague is unknown, we may preſume ſuch noxious Steams are not emitted; for tho' Sulphur is uſually found in many Countries where Metalline Veins are frequent; yet I never heard that in thoſe Mines an Ounce of Native Sulphur was ever found.

Beſides, tho' there may be Minerals in a Country which may emit noxious Vapours; yet the Mines from whence they come may by ſo deep in the Earth that they may not be able to infect the *Atmoſphere* powerfully enough to cauſe a Peſtilence, tho' promoted in making their Way

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by some violent Earth-quake, when upon a fall of some weighty Mass of Earth in Subterraneal Caverns a trembling Motion is communicated to the Earth about it, and propagated more or less proportionable to the first Cause; for which Reasons, noxious *Effluvia* being sometimes emitted which could not otherwise make their own way, probably the Plague happens in *Africa* once in 30 or 100 Years periodically. And a *French* Historian takes notice of a Disease in *France*, not much unlike the Colick, which, for a long time return'd every 10*th* Year. And *Plancus*, Lib. 2. *P. M.* 303. Relates that the Plague at *Brasil* successively return'd every 10 Years, for 70 Years together.

But further, tho' in the *East-Indies* such Vapours should arise, which would of themselves be pernicious; yet others may rise, which tho' noxious likewise, may by combining with them, form a Third Substance innocent enough: So Corrosive Sublimate, when combined with Crude Mercury, becomes so useful and innocent a Medicine as *Mercurius Dulcis*.

Besides what hath been said, another Reason why some Countries are free from the Plague, may be some peculiar disposition in the Air to resist the Effects of noxious Exhalations, as when the River *Nile* Increases and Over-flows, the Plague in *Ægypt* ceases: And the Soil in some Countries is of such a Temper as to impregnate the Air, so that it suffers not poysonous Creatures to live in it.

A Second Reason why I think the Plague is propagated by Subterraneal *Effluvia*, is, because it happens sometimes when no Distemper is per-

ceivable in the Air which ſeems able to produce ſuch an Effect; yet when the Aſpects of the Stars have been threatning enough, and the Air very intemperate, no Plague hath followed; as when *Fernelius* Writ his Obſervations *De abditis rerum Cauſis*, Lib. 2. Chap. 13. It was immoderately hot, but very Healthful; and the ſame further tells us, that the Plague hath ſometimes began in Winter, and gone off in Summer: And *Johannes Morellus*, that a Temperate and Healthful Spring, which ſucceeded a Winter, in which the *North*-wind Reign'd, brought in the Plague, tho' at the ſame time, the *North*-wind continued ſerene and clear. And the Conſtitution of the Air before the Plague in 1665, was not much unlike it. Whence it is evident, that the Plague depends not on manifeſt Qualities of the Air, but is rather cauſed by Subterraneal *Effluvia* which float in it, and which are drawn in by Reſpiration; and that Poiſonous Exhalations have roſe from the Earth and infected the Air with a Peſtilential Diſpoſition, Monſieur *de Meſzeray* in the Life of *Philip de Valois*, and *Diemerbroeck de Peſte*, Lib. 1. Chap. 8. teſtifie.

And tho' there is a manifeſt difference in Peſtilential Diſtempers in ſeveral Countries, and at different times; yet it is eaſily accounted for by our Hypotheſis, ſince the Minerals from whence thoſe Vapours riſe may be varied by new Combinations, and the Influence of Subterraneal Fires and Menſtruums, as well as in the open Air, by which they may be enabled to produce Symptoms more violent than in ordinary Diſtem-

Distempers; so that *Hippocrates* might well acknowledge in Distempers δαῖον τι, something above the ordinary Course of Nature.

As for the Natures of those Exhalations, tho' they are hard to be known, yet by the Effects and Symptoms of some Plagues, and of Yellow, Red, and White Orpiment, we may suspect them to flow from that Mineral Substance; but tho' I believe some Plagues may arise from such Causes, yet since the Earth abounds with several Minerals which we are not acquainted with, we cannot deny but by the combinations of such, there may result Substances which yeild *Effluviums* hurtful enough to human Bodies; so by adding Common Salt to Orpiment, they prepare White Arsnick, which by the Mixture of Salt, of it self innocent, becomes more pernicious, causing violent Symptoms, which I have taken off by Oil of Sweet Almonds and something made of Limons; And Sandarach, as well as Native Arsnick, seem to be little else than Red and White Orpiment, the Effects of which are taken Notice of by *Sennertus. M. P. E.* vid. *Page* 66. on a Painter, whose Face was swell'd, together with Fainting Fits, upon opening a Box where Orpiment had been kept some time. And White Arsnick hath had very fatal Effects, when externally worn in Amulets, sometimes causing burning Fevers, Anxieties about the Heart, inflammations, exulcerations of the Breasts, Black Pustles, as if made with a Caustick, weakness and Fainting, and sometimes sudden Death, which Symptoms have been cured by the same Antidotes that the Plague is. And that Subterraneal Mineral *Effluvia* are able to effect ve-

The ill Effects of Mineral fumes

very ſtrange things, appears from what *Kircherus* obſerves, *Scil.* That in the Kingdom of *Naples* 1660, there were ſeveral Stains obſerv'd on Linnen Clothes, much reſembling Croſſes, that poyſonous Matter which was the Cauſe of them, being ſpread along the Threds, which croſs'd one another at right Angles. Theſe Stains would waſh out with Soap and Water; but their duration was very unequal, ſome of them continuing ten, and others fifteen days.

Antidotes against the ill Effects of the Plague.

And tho' it be impoſſible to diſcover the Natures of all noxious Effluvia; yet, undoubtedly a great many may, and Antidotes thought on to deſtroy their ill Effects. In the great Plague of *London*, when upon a Subſidence of the Peſtilential Humors, the Patients uſually dyed, the following Plaſter apply'd to the Tumors of ſeveral, prevented them from falling; and either burſt or made them fit to open; and ſo ſaved the Lives of many.

Emplaſtrum attractivum Peſtilentiale noſtrum.

℞. *Gum. ſagapen. Ammon. Galban.* an ℥iij. *Terebinth. Lat. Cera Virginis* an. ℥iiiſs. *Magnet. Arſenicalis ſubt. pulv.* ℥ij *Rad. Aron. pulv.* ℥j *Gummi depurentur cum Acet. Scyllit. & ad conſiſtentiam Emplaſtri coquantur, & poſtea ponderentur, deinde cum reſtis aliis F. Empl. S. A. Hoc Emplaſtro Carbunculus obducatur, quod paucis horis Venenum extrahit.*

Pre-

Præparatio Magnet. Arsenicalis antea dicti.

℞ *Arsen. Chrystallin. Sulphuris Vitri, Antimonii Crudi an. Hectria in mortario ferreo pulverisentur. In Vase fortissimo Vitreo, ponantur ad ignem arenæ, donec vitrum optime incalescat, & prædicta solvantur & liquentur instar Picis, quod observabitur quando filum quoddam immittitur in fundum, quod extractum postea instar Terebinthinæ trahetur ubi satis coctum erit. Postea remove vitrum ab igne, & subtiliter pulverisa & ad usum serva.*

Another eminent Physitian preserv'd himself from the Plague, by taking every Morning a little Sea Salt dissolv'd in Sea Water: And in another Plague, I knew two recover'd with a Conserve made of Goats Rue.

Why the Plague sometimes unexpectedly ceases.

But further, besides what hath been discours'd on; it is not less disagreeable with our Hypothesis, that sometimes the Plague unexpectedly ceases; since those subterraneal Effluvia, which continue the Infection, ceasing to be emitted from the Earth, those in the Air are soon spent and swept away with the Wind; which Effluvia may cease to be emitted; either because they meet with some other Effluvia in the Earth, which corrects them; or because they primarily rose from a Conflict and Agitation, depending on the mutual Action of two Bodies; which as Spirit of Salt pour'd on filings of Iron, or *Aqua fortis* on Salt of Tartar, emit Fumes less plentifully, as the Ebullition declines. And that noxious Exhalations may be corrected, by a combination of others as pernicious, not only appears from what hath been before deliver'd; but

may be illuſtrated by noting, that tho' Spirit of Salt-Peter will corrode Silver; yet, if Spirit of Salt be added to it, it ſoon loſes that Quality.

PROPOSITION IV.

It is very probable, that moſt of the Diſeaſes, that even Phyſitians call new Ones, are cauſ'd either chiefly or concurrently by Subterraneal Steams.

New Diſeaſes cauſ'd by ſubterraneal Steams.

BY new Diſtempers, I would be underſtood to mean, not every one that varies a little in Symptoms from the ſame ſort at another time; but ſuch as at their appearance are, by their Symptoms altogether unknown: That theſe Diſtempers depend not on any intemperate and manifeſt Qualities of the Air; nor on the influence of thoſe Heavenly Bodies, that move about us, ſeems evident; becauſe the Influence of the latter are too indeterminate, and the alterations in the Temper of the Air, much more frequent than the Acceſs of new Diſtempers.

But from what hath been ſaid under the Third Propoſition, it appears, that the Globe we inhabit, abounds with various noxious Mineráls, which are ſubject to various Confluxes, Conflicts and Diſſipations; and which, by emitting Effluvia, may infect the Air, and cauſe new Diſeaſes, which may continue accordingly, as the Cauſe is more or leſs durable; ſo Manna for theſe two or three Ages hath been found on certain Trees, which faculty of producing

ducing Manna, they still retain, yet had it not before.

To conclude this Chapter, and to render what we have taught concerning mineral Effluvia more probable, I shall add the following Experiments; from whence it will appear, that malleable Metals may be rais'd in the form of Vapours into the Air, and become part of Fumes, or perhaps of Invisible Vapours, or even of Flame it self. *Experiments to shew that Metals may be rais'd in the form of Vapours.*

EXPERIMENT I.

HAving powdered three Pound of *Dantsic* Vitriol, and two of Sea-salt, and distill'd them with a strong naked Fire; we obtain'd a blew Spirit of Salt: Besides which there rose a Powder of a Cupreous and Martial Nature, which settl'd in the bottom of the Liquor. *Dantsic Vitriol and Sea Salt Distill'd.*

EXPERIMENT II.

THE former Experiment being repeated with *English*, instead of *Dantsic Vitriol*, we obtain'd a Yellow Spirit, with a Yellow Powder, which seem'd to be a *Crocus Martis*. *English Vitriol and Sea Salt.*

EXPERIMENT III.

WE cast thin Plates of Copper into a Retort upon a double weight of good *Mercury Sublimate*, and having luted on the Receiver, by a long continued Fire, we obtain'd some running Mercury, and some Sublimate, which *Mercury Sublimate and Copper.*

which had not faſtned upon the Copper. In the Bottom of the Retort we found a weighty, brittle and reſinous Subſtance, fuſible and inflammable, almoſt like Sealing Wax; this being beaten and expos'd for ſome time to the Air, turned to a kind of Verdigreeſe, which gave a green Tincture to Spirit of Salt. This being Diſtilled *ad Siccitatem* ſeveral times, till fully impregnated with the Spirit; it was mix'd with Triply, and with a ſtrong Fire afforded a colourleſs Liquor, like Water, which upon an Addition of Spirit of Harts-horn turn'd Blew.

EXPERIMENT IV.

Venetian Sublimate and Corniſh Tin.

Venetian Sublimate Diſtill'd from *Corniſh* Tin, into a good large Receiver, yielded a Spirituous Liquor, which emits white Exhalations, upon an Acceſs of free Air; but if the Orifice of the Veſſel be but cover'd with a Piece of Paper, it preſently ceaſes to emit thoſe Exhalations; yet begins again, when that Paper, which lay but lightly upon it before, is taken off: Whence it appears, that the Air may promote the riſing of metalline Vapours in the *Atmoſphere*.

Air promotes the riſing of Metalline Vapours.

And that Metalline Fumes will aſcend in the form of Vapours, will appear from the following Experiment, *viz.* Having ſatiated *Aqua fortis* with Copper, and ſteeped ſome brown Paper in it to ſoak up ſome of the Menſtruum, when the ſuperfluous Moiſture was partly evaporated, we laid ſome of it upon the Hearth, near a Wood Fire, upon which, the Paper being

ing Scorched, emitted Fumes like Smoak, which rising up in the Air, as soon as they came to the Flame, they imparted to it a Colour, partly Blew, and partly Green; as it was variously mix'd with the Flame and Smoak of the Wood.

CHAP. XX.

Suspicions about some hidden Qualities of the Air.

BEsides the four first Qualities of the Air, *viz.* Heat, Cold, Moisture and Driness, and those which Philosophers and Chymists have discover'd, as Gravity, Springiness, *&c.* I am apt to suspect, that there are other latent Qualities in it, due to the substantial Ingredients, which it is made up of: For the Air we live in, is not a simple Body, but a confus'd Aggregate of Effluviums; which, being jumbl'd together, constitute a great Mass of Heterogeneous Matter, endew'd with different Qualities. *Latent Qualities in the Air.*

For from what is elsewhere deliver'd, it appears, that there are various Effluvia, besides those that afforded ordinary Meteors, which arise from Bodies in subterraneal Parts; several of which have no Names, or at least none assign'd them, and have several Powers and Qualities which we know not of.

Besides,

Besides, the Sun and Planets may have Influences here below, distinct from their Heat and Light, which may mix with the *Atmosphere* we live in: And for as much as those celestial Globes that move about us, may be endew'd with substances, that we here know nothing of, the Effluviums which come from them, may affect us in a different manner from any Bodies we here have in our *Atmosphere*. And tho the greatest Part of those Effluviums, which are active in our *Atmosphere*, arise from subterraneal Parts, and from Celestial Bodies; yet doubtless there are a great many that result from the mutual Action of the different Parts of it acting on those Bodies that are expos'd to it; for tho', notwithstanding any manifest Qualities we can discern in it, the Air seems to be unfit for a Menstruum; yet I doubt not, but it may have considerable Effects on Bodies dispos'd to be acted on by it; for not to urge, that sometimes the Quantity of a Menstruum compensates it's want of strength; we know, that there are several Liquors, which, tho insipid, and make no sensible Impressions, on the Organs of Taste, yet by their various Attritions and frequent Motions against Bodies, become fit for *Solvents*: So the Air, having it's Parts always acting on Copper expos'd to it, in tract of time, produces that Efflorescence colour'd like Verdigrease; a factitious Body usually produc'd from the same Substance corroded by Vinegar or the Juice of the Husks of Grapes. Besides, we see, that Mercury, which hath no sensible Taste, hath a faculty of Dissolving Gold and Silver, and all Strong Menstruums, which dissolve

Qualities in the Air which arise from the Union and Conjunction of other Bodies with it.

ſolve Bodies with the utmoſt Vigour, are ſoon glutted, and can diſſolve no more; ſo that, tho' the Air be a weak one, yet it hath this laſting Advantage, that when a ſmall Quantity of it is glutted, it bears ſo great a Proportion to the Body it acts on, that a freſh Part of it is ſtill to ſupply the Deficiency and Place of that which can act no longer.

Beſides, the Air abounds with ſo many ſaline and ſulphureous Parts, that by rubbing upon Bodies that lie in their way, by frequent occurſions, they cauſe conſiderable Effects, ſo we ſee, according to the Proverb, *The Air abounds with ſaline and ſulphureous Parts.*

Gutta cavat Lapidem, non vi, ſed, ſæpe cadendo.

Moreover, tho' the Parts of Air are very minute, yet, we know, that the Bodies which are expos'd to their Action, are only acted on by them upon their outward Superficies, which may conſiſt of as many Parts, and as minute as thoſe of the Air, which, by ſucceſſively hitting againſt them, carry them along with them: So Sugar or *Sal Gem.* being immers'd in Water, have their Parts diſſolv'd and carri'd up into the Liquor, by the ſucceſſive attritions and occurſions of ſo inſipid a Menſtruum, and whoſe Parts are in ſo gentle a Motion.

And I am apt to believe, that ſome Bodies have may ſuch a diſpoſition, to be worked upon by the Sun-Beams, as to be rais'd by them in ſuch a form, as not to be diſtinguiſh'd from the Body they are rais'd in. But whether they may or not, certainly it is conſonant to Experience, that the *Atmoſphere* is fill'd, in ſeveral Places, with *The Sun-Beams ſufficient to raiſe ſome Bodies.*

with Effluviums of different kinds, and of uncommon or unobserv'd Natures; which Conjecture may be favour'd, by observing, how subject Camphire is to waste; and that, when the Superficies of some solid Bodies have been taken off they emitted Steams copiously, by which in a Minute of an hour, they suffer'd a manifest decrement of weight.

Arguments to prove latent Qualities in the Air.

But to reassume the Discourse we have made this Digression from, I shall urge some Arguments *à posteriori*, which favour what I propos'd concerning these latent Qualities in the Air.

And first, I shall urge the appearing growth of some Salts, in Bodies, which usually afforded them not at all, or not in such plenty; Vitriolate Efflorescences having been observ'd to be, after sometime, on the glistering parts of Marchasites, which were kept in a dry Room: And it hath been observ'd, that a heavy ponderous Mineral expos'd to the Air for some time, became so brittle, that it would crimble away, and plentifully abounded with Copperas; and some of the same being kept in a close and dry Place, was in some time covered over with an Efflorescence, which being mix'd with an Infusion of Galls, manifested it self to be a Vitriol; whose growth is the more strange in the Air, because it is not a meer Acid Salt; but abounds with combustible and sulphureous Parts, which I have often separated from common Vitriol without the addition of any combustible Matter; and sometimes without any addition at all. And it was not a little strange that our blackish Minerals, yielded vitriol Efflorescences so soon, since I kept shining Marchasites, from whence they

they uſually prepare Vitriol, without being changed near ſo much, as thoſe I have mention'd; and it is uſual, ſometimes, to let them lie expos'd to the Air two Years, before they yield their vitriolate Parts.

Alum Ore regains it's Salt when expos'd to the Air.

To theſe Obſervations we may add, that Alum Ore, being robb'd of it's Salt, recovers it again by being expos'd to the Air; and Lime in old Walls hath in time regain'd a Nitrous Spirit, which I have learn'd by diſſolving it in common Water, and evaporating the filtrated Solution. Nay, calcin'd Vitriol expos'd to the Air, in a competent time regains freſh Parts of a vitriolate Salt.

And ſo does Vitriol.

Suſpicions about the Productions of Vitriol.

But tho I propoſe theſe Obſervations as favourable to the Suſpicions laid down; yet I am apt to ſuſpect, that the Air concurs to the Production of them, rather as an Ingredient, than as an Agent; or that the Production of them depends on ſome ſeminal Principle, by which, when they are once ripen'd, the Moiſture of the Air helps them to diſcloſe themſelves in the Form of ſaline Concretes; as in Tartarous Matter ſaline Parts are generated, which cauſe that acid Taſte in Tartar, of *Reniſh* Wine eſpecially; Beſides, it may be ſuſpected, that the *Sals* found in Marchaſites, &c. may be made of ſaline Particles ſwimming in the Air, and attracted by congenerous Particles, that remain in thoſe Bodies, that are, as it were, the Wombs of ſuch Minerals; or that theſe Aerial Salts, aſſiſted by the Moiſture of the Air, open the Textures of theſe Wombs, and by extricating the latent ſaline Parts, and adjoyning with them, compoſe thoſe emergent Bodies;

but

but tho I suspect, that the Air is not wholly concern'd in producing such Bodies, yet I believe it is in a great measure concern'd, as I have already intimated.

The necessity of Air to continue flame, an Argument of a latent Principle.

But to proceed to other Instances of these Aerial latent Qualities, I think that the necessity of the Air's Presence to preserve and continue Flame, is a sufficient Argument of some latent Spirit or Quality, whether vital Substance or nitrous Spirit diffus'd through the Air, on which likewise the Life of Animals depends, and without which, they, as well as Flame, presently, are extinguish'd and die.

To these I shall add, that Animal Substances enclos'd in *Vacuo*, yield not Insects, as when expos'd to the open Air; And it is related by a Noble Man of this Country, that an Oak being dug out of a Rock of Salt, was so hard, that Iron Tools could scarce work upon it; yet in three or four Days, being expos'd to the Air, it was rotten. And it hath been observ'd by several, that the Air hath such an Influence on Diaphoretick Antimony, that if it be long expos'd to it, it becomes *Emetick*.

The Air seems to consist of all sorts of seminal Principles.

From which Observations, and what I have before laid down concerning Quick-Lime, the Air seems to be a Substance capable of being assimilated by every Body, or that it consists of all sorts of seminal Corpuscles; so that any Body may find a Substance there, analogous to it, and fit to make up a part of the same Body.

But without any further notice of this odd Surmise, I shall subjoyn the following *Phænomena* to favour my Suspicion. The first is, That tho'

tho' the Juice of the Fruit of the Tree *Jenipa* (which the *Indians* uſe to black their Faces, to make them more formidable to their Enemies) gives ſuch a Tincture, that it cannot be waſh'd out with Soap; yet the Air abounds with Particles of ſuch a Nature, that it diſappears in ten Days time; tho' I ſuſpect that, it in a great meaſure depends on the continual Excretion of Sweat, through the Pores of the Skin.

And I am inform'd, that Inſtruments made of *Damaſco* Steel, tho' when firſt made, they excel not, or ſcarce equal thoſe of common Steel, yet when kept in the Air two or three Years, they anſwer Expectation and are mightily improv'd. And I have obſerv'd, that a Metalline Body, which would not be diſſolv'd in a ſtrong *Menſtruum*, nor loſe it's Colour by Fuſion, would preſently be turn'd black, if expos'd to the Air. Damaſco Steel improved.

It is obſerv'd in Blood concreted, that the black internal Parts being expos'd to the Contact of the Air, become florid; and I have prepar'd a factitious Concrete, which if kept to the Fire, or ſecluded from the Air, would be of a red Colour; yet in a quarter of an hour, being expos'd to the Air, it would turn almoſt black. To which I ſhall add, that an inquiſitive Perſon prepar'd a Medicine of a vegetable and Animal Subſtance, which at that time of the Year would be coagulated in a Viol like Oyl of Aniſeeds; but if unſtopp'd and expos'd to the Air, it would preſently diſſolve again, and recoagulate when ſtopp'd up again; The Conſideration of which Experiments may tell us, that the Remarkable Changes of Colours.

but tho I suspect, that the Air is not wholly concern'd in producing such Bodies, yet I believe it is in a great measure concern'd, as I have already intimated.

The necessity of Air to continue flame, an Argument of a latent Principle.

But to proceed to other Instances of these Aerial latent Qualities, I think that the necessity of the Air's Presence to preserve and continue Flame, is a sufficient Argument of some latent Spirit or Quality, whether vital [illegible] stance or [illegible] Air, on [illegible] depends, [illegible] as Flame, [illegible]

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From w[illegible] before lai[illegible]

The Air seems to consist of all sorts of seminal Principles.

Air seems [illegible] assimilated by every Body, or that it consists of all sorts of seminal Corpuscles; so that any Body may find a Substance there, analogous to it, and fit to make up a part of the same Body.

But without any further notice of this odd Surmise, I shall subjoyn the following *Phænomena* to favour my Suspicion. The first is, That tho'

tho' the Juice of the Fruit of the Tree *Junipa* (which the *Indians* uſe to black their Faces, to make them more formidable to their Enemies) gives ſuch a Tincture, that it cannot be waſh'd out with Soap; yet the Air abounds with Particles of ſuch a Nature, that it diſappears in ten Days time; tho' I ſuſpect that, it in a great meaſure depends on the continual ...ion of Sweat, through the Pores of the

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Air by being communicated to the Blood by Reſpiration, may have Effects not inconſiderable upon it, in carrying off it's fuliginous Recrements,

To what hath hitherto been deliver'd in favour of our Suſpicion, it may be added, That there are Anonymous Subſtances and Qualities in the Air; To countenance which, I ſhall take notice of thoſe various and odd Diſeaſes, incident both to Men and Beaſts, which prove Mortal to a particular Species of Animals, and in particular Places, which depend on ſome unknown ſubterraneal Vapours: To which I ſhall ſubjoyn, that *Fernelius* mentions a Plague, which affected no Animals but Cats; *Dionyſius Halicarnaſſus*, takes notice of one that only affected Maids; whereas, that which raged in the time of *Gentilis*, ſeiz'd none but Luſty Men: And *Bolerus* gives us an Account of another, which only affected the younger ſort of People. *Cardan* ſpeaks of a Plague at *Braſil*, which only affected the *Switzers*, and neither the *Italians*, *French* or *Germans*; and *Johannes Utenhovius* gives an Account of a cruel Plague at *Copenhagen*, which only raged amongſt the *Danes*. As for the Cauſe of theſe Diſeaſes, tho I think they are chiefly to be aſcrib'd to ſubterraneal *Effluviums*; yet I deny not, but that the Particular Conſtitutions of Men are concern'd in them; nor do I think the Diſtempers already mention'd, alone depend on ſuch Steams as riſe from the Earth, but the *Sudor Anglicus* in the 15*th* Century, the Scurvy and the *Morbus Hungaricus*, the

Lues

Lues Moravia, *Novus Morbus Luneburgensis*, and some others in the last Century.

Considerations drawn from what hath been said.

And now, if from what hath been said, our Suspicions concerning Subterraneal and Sydereal Steams, may seem not ill grounded; they may lead us to consider the following Particulars.

1. Whether those Effects, which are sometimes thought to depend on the immediate Wrath of God, and the Intercourse of Angels, may not arise from these Steams, whose Qualities are probably heteroclite, and unknown; since we see that there are several Steams dispers'd through the *Atmosphere*, which cause it to raise Mercury in a Baroscope, which could be no otherwise discover'd, but by the Effects they have on the Air, made evident by that Instrument. And this Consideration hath sometimes made me suspect, that even the Sun-Beams may cause a manifest Gravity in the *Atmosphere* besides that which they do by virtue of their Heat; and it may be worth Enquiry, whether some Spots in the Sun, upon their Dissolution, may not be dispers'd through, and cause some considerable Effects in our *Atmosphere*, at least in it's Gravity.

2. It will not seem improbable, that some Bodies have peculiar Dispositions to be associated with those Exotick Principles, which arise from subterraneal Parts, or are transmitted from the Planets. Upon which Dispositions, or the contrary, what we call Sympathy and Antipathy depend. By Virtue of such Dispositions, a Burning-Glass refracts the Sun-Beams, and the Sun-Beams impart a Lucidness to the *Bolonian*

Stone. And that the Steams of ſubterraneal Bodies will act on ſome Bodies, and not on others we have given ſufficient Proof.

3. The third thing which may be ſuggeſted by what we have deliver'd; is, whether there may not be *Receptacles* or *Attractives* of Syderial and other Exotick *Effluviums*, that wander up and down the Air, ſuch as are Magnets; by which I mean, not ſuch a Body that can attract foreign *Effluvia*; but ſuch a one as can detain them, when by virtue of their various Motions they happen to come near ſuch a Magnet. Juſt as *Oyl of Tartar per Deliquium* draws to it, aqueous Vapours, and embodies with them, when they chance in their Paſſage through the Air to come near it.

But a greater reſemblance of the Magnet may be allow'd to ſome Bodies, than what is here mention'd; for ſuch a Magnet may not only by a Juxta-Poſition or Contact detain the *Effluviums*, that would glide along it; but alſo arreſt thoſe ſubtle Parts of Matter by a kind of precipitating Quality; and ſo it may fetch in ſome *Effluvia*, which would otherwiſe paſs by it: On which occaſion, I remember, that in ſome Caſes, I have been able to give ſome Bodies Electrical Qualities, without exciting them by rubbing, *&c.*

CHAP.

CHAP. XXI.

Some Additional Experiments relating to Suſpicions about the Hidden Qualities of the Air.

EXPERIMENT I.

Experiments relating to occult Qualities of the Air.

HAving pour'd Water upon the *Calx* of *Dantzick* Vitriol, part of it, ſoon after it was ſufficiently impregnated, with the Vitriol remaining in the *Calx*, was filtred and gently abſtracted, and yeilded ſeveral Grains of a Salt of Vitriol, not much different from that which had been calcined. Another Portion of Water was left in the Air ſix Weeks, upon the calcined Vitriol in a wide mouth'd Glaſs, and then being abſtracted as the former, it yeilded a Salt much like *Salt-Petre*, and different from the former. And *Colcothar* which had lain ſeveral Months in the Air free from Rain, being turn'd into a *Lixivium*, yeilded a Salt much whiter than Vitriol, and of a different Figure. From whence it appears, that the Air hath conſiderable Force in varying Salts obtainable from calcin'd Vitriol.

EXPERIMENT II.

DUlciſi'd *Colcothar* of Venereal Vitriol being expos'd to the Air in *January* and *February*, increas'd in Weight 4¼ Grains.

EXPERIMENT III.

THE 12*th* of *March*, Eight Ounces of Outlandiſh Vitriol calcin'd to a Redneſs, being put into a broad and flat Metalline Veſſel; and into another Veſſel ſmaller than the other, we put 2 Ounces of *Colcothar*, ſo that the Superficies of the latter, was larger, in reſpect of it's Quantity than the Superficies of the other. *June* 25. We weigh'd theſe Powders, and found that the 8 Ounces had gain'd a Drachm and 16 Grains, and the 2 Ounces had gain'd as much within a Grain. Then the Powders being put into the ſame Veſſels, *Auguſt the* 4*th*, the ſmaller Quantity weigh'd 26 Grains more than it did in *June*. Whence it appears, that different Circumſtances cauſe notable Diſparities in the Increaſe of Weight.

EXPERIMENT IV.

TWO Ounces of ſmall Lumps of Marchaſites, which were partly ſhining, and partly darkiſh, and ſeem'd well diſpos'd to yeild Vitriol, were kept in a pure Air, and gain'd 12 Grains in Weight in ſeven Weeks.

EXPERIMENT V.

SPIRIT of Salt being put upon Filings of Copper, and kept in a moderate Heat, when it had acquir'd a thick and muddy Colour, we decanted it into a clean Glaſs, with a wide Mouth, and left it a competent time expos'd to the Air, till

till it had acquir'd a fair Green; yet nothing was precipitated to the Bottom to make it clear.

EXPERIMENT VI.

I Once Obſerv'd, that the Fumes of a ſharp Liquor acted more powerfully on a certain Metal, held in the Air, than the *Menſtruum*, from whence thoſe Fumes roſe, would do it ſelf. And it is obſerv'd in ſome Mines in *Hungary*, that the Fumes render thoſe Ladders ſooneſt unſerviceable, which were neareſt the Top of the Grove, where there is a more free acceſs of Air.

EXPERIMENT VII.

A Soft Chymical Subſtance, which would ſmoak in the open Air, being conveigh'd into our Pneumatick Engin in a Viol, when the Air was exhauſted, ceaſed to ſmoak; and by continuing there ſome time, would not ſmoak again, when it was re-expos'd to the Air, till the freſh Air had blown upon it ſome time. This Preparation, being kept in the Veſſel it was prepar'd in ſix Weeks, would ceaſe to ſmoak, when the Veſſel was but cover'd with a piece of Paper; and another remarkable thing was, that when it was contain'd ſome time in a Receiver, cloſe Luted, it would ſoon ſo glut the Air with it's Steams, as not to be able to ſmoak longer.

CHAP. XXII.

Of the Celestial and Aerial Magnets.

Of Celestial Magnets, &c.

IT would be of great Use in discovering the Nature of the Air, and it's Correspondency with Subterraneal and Celestial Regions, could we, by Experiment, make any progress in preparing such artificial Magnets, as would imbibe the Exotick Parts of the Air.

Nor will it be lost Labour to expose several Mineral and other Substances to the Air, and to enquire, what it is that gives them the additional Weight, they receive by it; and with what Qualities that Substance is endew'd; for if such Experiments could be try'd with good Magnets at several times, and in several places, we might by them learn, what *Effluviums* the Air, then, and in those places, abounded with; nor might it be of small Importance in discovering a correspondency betwixt the Terrestrial and some Etherial Globes of the World.

Amongst other things which make me hope that Equiries of this Nature may not be altogether unsuccessful; I shall only intimate, that Notable Operation the Air hath upon Vitriol, diversified by circumstances, after Fire could work no further on it: For *Zwelfer* speaking of a Chymical Preparation of Vitrol, *Viz. Colcothar*, says, that the Salt it yeilds, when long kept, is imbibed into it, from the Air. For, says he, when it hath been exposed to the Air, *Sal præbet, quandoq; candidum, quandoq; purpureum, aspectu pulcherrimum, quod aliquando in Copia acquisivi, & penes me asservo, quandoq; etiam Nitrosum.* And an ingenious Person told me, that he likewise had obtained several sorts of Salts from *Colcothar*, and

and at the laſt, when it had been kept a long time, a pretty quantity of true running Mercury.

Beſides what hath been already ſaid, concerning *Colcothar*, I ſhall propoſe two or three Inquiries, to any Virtuoſo, that would aſſiſt in theſe Tryals.

And firſt, it will be convenient to note, the Nature of the Soil; the Temperature of the Air; the Month of the Year; the Winds; the weight of the *Atmoſphere*; and, if any, the Spots of the Sun; the Moon's Age, and her place in the *Zodiack*, as well as the principal Aſpects of the Stars and Planets; ſince we cannot deny, tho' not poſitively aſſert, that theſe Bodies are concern'd in the production of thoſe Salts which *Colcothar* yields: This, nevertheleſs we know, that, tho' thoſe Bodies which move about us, ſhould have no conſiderable effect on what is done in our *Atmoſphere*; yet it, at different times and Places, abounds with various ſubterraneal Steams, and ſeveral *Phænomena* appear in it, which are irregular, and tho' ſome are regular enough, yet are they as to their Cauſes unknown, as thoſe *Therma Piperina* in *Germany*; which begin and ceaſe to flow at certain times: And *Johannes de Laet* tells us, that in the *Mexican* Province, *Xilolepec*, there is a Fountain, which ſucceſſively flows and ceaſes to flow for four Years together; and in the time of it's flowing, it's obſerv'd, that it flows much more plentifully in dry, than Rainy Weather.

Secondly; I would recommend the following Obſervations, *viz.* What kind of Vitriol the *Colcothar* is made of, *Martial*, *Hungarian* or *Roman* Vitriol; what degree of Calcination is made uſe of, and how far the Calcin'd Matter is freed from it's Salt by Water: For I have obſerv'd,

serv'd, a Saltless *Colcothar* expos'd to the Air several Months, without the least increase of Weight, which probably might depend on some Peculiarity of the Air, where the Experiment was try'd, since in other Places, the success hath been the contrary.

But *Thirdly*; Besides several sorts of Vitriols, it may not be amiss to try these Experiments with several Preparations of them; for I once made a Solution of Copper with Sublimate and Spirit of Salt; which, expos'd to the Air, was green, tho' before, it was not of that Colour, but of a muddy Red; and some which, appear'd to be a dirty Liquor, as long as it was kept in the Vessel it was made in, free from the Air, appear'd to be of the Colour of an Emerald, when expos'd to it. And what was remarkable in these Experiments, is, that accordingly as the Qualities of the Matter and Circumstances differed, the green Colour appear'd sooner or less speedily.

But to conclude: Tho' the success of Experiments of this kind be very doubtful; yet since the Attainments are so desirable, it may encourage the curious, not to pretermit the Advantage, which may succeed such Endeavours: For as Mariners at Sea, who at a distance upon the *Horizon*, some times see something obscure which, whether it be a Cloud, a Mountain, or an Island, they cannot distinguish, yet it hath prov'd worth their while to approach it, and not lose the probability of a Discovery; so, who knows, but by making an advance in less promising Experiments, we may discover something which may richly reward our Pains.

CHAP.

CHAP. XXIII.

Experiments and Notes about the Mechanical Production of Magnetical Qualities.

Magnetical Qualities Mechanically prod.

THo' the Operation of a Load-ſtone is juſtly reckon'd amongſt occult Qualities, and thought to flow from the ſubſtantial Form of the Magnet; yet I ſee no Reaſon, why it may not be eaſily mechanically produc'd; ſince a Piece of Steel, fitly ſhaped, and well excited like a Load-ſtone, points to determinate Poles, *viz. North* and *South*, draws other Pieces of Steel to it, and Communicates to them in a ſmall degree the ſame Attractive and Directive Virtues, which are not ſlight and tranſient Impreſſions, but durable and laſting; where it is evident, that, tho' the Steel is endew'd with magnetical Virtues, yet it hath not the Form of a Load-ſtone; but only, the Metal by the Action of a Load-ſtone acquires ſuch a diſpoſition in it's Parts, as inables it to perform Magnetical Operations; which Power it loſes again, by being heated red hot, and cooled in the Air, yet the Form of the Steel is ſtill the ſame: And from what I have in another place laid down, it appears, that a Load-ſtone it ſelf may loſe it's faculty of attracting Iron, and yet retain all it's other Qualities; Nay, tho' it is a peculiar Quality of a Load-ſtone, to point *North* and *South*; yet without deſtroying it's ſubſtantial Form by Fire, the Poles may very eaſily and ſpeedily

ſpeedily be chang'd, if a ſmall Fragment of a Load-ſtone hath it's Poles ſucceſſively applied to a very vigorous Magnet.

But to make it further appear, that Magnetical Qualities may be Mechanically produc'd, or alter'd; I ſhall add, that I have obſerv'd, that whilſt the Parts of well temper'd Steel have been excited to Motion by Rubbing, they would draw to them Filings of Steel, or thin Fragments of Steel or Iron; but when the Adventitious Warmth acquired by that attrition ceaſes; they preſently loſe their attractive Power: And I have elſewhere obſerv'd, that the lower end of a perpendicular Bar of Iron, hath been ſo far alter'd by the *Effluvia* of the terraqueous Globe, as to be turn'd into a kind of Magnet, whoſe lower end becomes the *North* Pole of it, and the other the *South*; to which Obſervation we may add, that if the Bar of Iron ſtand but a while in an erect Poſture, the Magnetical Qualities of it will be ſo tranſient, that if the upper End, which attracted the *North* end of a Needle, be inverted and held downward, it will drive it away; and on the contrary, if it remain a long time in that Poſture, the change wrought upon it is ſo great, that a Piece of a Bar of Iron, which was upon the Top of a Church, call'd *Arimini*, in *Italy*, by the Ruſtyneſs of it, and the Magnetical Virtues it had acquir'd, ſeem'd to be turn'd into a Load-ſtone.

And further, it may be obſerv'd, that if a Piece of Iron, have it's Pores open'd and looſen'd, it imbibes the Magnetical *Effluvia* of the Earth ſo faſt, as to acquire Magnetical Virtues much ſoon-

ſooner. And here it may not be uſeleſs to obſerve, what different Effects, Fire hath upon two different Bodies; for by keeping a Load-ſtone red hot, it loſes it's attractive Power, tho' afterwards, it be cool'd in a perpendicular Poſture; whereas, Iron, by being heated and cool'd in a perpendicular Poſture, acquires a manifeſt Virticity; ſo that the internal Texture and Conſtitution of the Load-ſtone, ſeem'd to be deſtroy'd and weaken'd by Ignition: From whence likewiſe it appears, that Magnetical Qualities may be altered by, and depend on Mechanical Principles. And,

To theſe Obſervations, I ſhall add further, that having brought a Piece of Oker to a convenient Shape, and after I had heated it red hot, ſuffered it to cool in a convenient Poſture, it was able to exerciſe Magnetical Operations on a poiſed Needle. And, indeed, a convenient Poſture, ſo much contributes to the preſervation of Magnetical Qualities, that leaving a very vigorous Load-ſtone, for ſometime, in an inconvenient Poſture, it loſt conſiderably of it's Magnetical Virtues. And this corruption of Magnetical Qualities is further evident in an excited Needle, which, as it is variouſly touch'd with this or that end of a Load-ſtone, points with this or that end *North*-ward or towards the *South*.

To make it yet more probable, that Magnetical Virtues may be Mechanically produc'd and deſtroy'd, I ſhall ſubjoyn, that by an Experiment tryed by the Ingenious Dr *Power*, it appears, that a Bar of Iron, ignited, and ſuffer'd to cool *North* and *South*, and hammer'd at both Ends, will

will loſe it's Magnetical Virtues, by two or three ſmart Blows, upon the middle of the Bar, with a Hammer.

CHAP. XXIV.

Chymico-Magnetical *Experiments and Obſervations.*

Magnetical Experiments and Obſervations.

THE Load-Stone being a Body, whoſe Nature is ſo little known, and whoſe Qualities are ſo admirable, I ſhall, in order to the better Underſtanding of it, lay down ſome Experiments, made upon ſeveral, brought from different Countries, and of different Sizes, Shapes and Colours.

But before I proceed to them, it is requiſite to advertiſe, That although the Title of this Chapter be *Chymico-Magnetical*, yet all the Experiments contain'd in it are not Chymical, ſeveral others being mix'd with them. Alſo it is requiſite to note, that Iron and Steel being uſually reckon'd amongſt Magnetical Bodies, I have alſo added a few Experiments made upon them.

EXPERIMENT I.

SEveral Stones being heated in the Fire, had, by the Action of it, their Texture viſibly alter'd; ſome being brittle, others flying aſunder

der of their own Accord, whilſt others contin'd whole; in which it was obſervable, when broke, that ſome were not unlike Iron Ore; whereas others were ſhatter'd into flakes or plates of various Colours: But ſome, which were *Engliſh*, reſerv'd their Solidity and Colour.

EXPERIMENT II.

SEveral ſmall Load-Stones being burnt, we could not perceive the leaſt of that ſulphureous blew Flame, which *Porta*, *Lib.* 7. *Cap.* 7. of his Nat. Magick, takes notice of.

EXPERIMENT III. & IV.

IT is worth obſerving, that ſeveral Load-Stones, being ſtruck with Steel, afforded Sparks of fire much bigger than thoſe that are uſually ſtruck from Flint. Whereas two cubial pieces of Load-Stone being ſtruck together, afforded Sparks, but not ſo large as the former.

EXPERIMENT V.

IF an oblong Load-Stone be cool'd in a perpendicular Poſture, the lower End becomes it's *Northern* Pole; yet if that End inſtead of being expos'd to the *Effluvia* of the Earth be cool'd, whilſt reſting on the *Northern* Pole of a ſtrong Load-Stone, it will be the *Southern* Pole, and will attract the *North* End of a Needle.

EX.

EXPERIMENT VI.

IF a Load-Stone, which hath loſt it's attractive Virtue, be heated red hot, and cool'd in a perpendicular Poſture upon the *North* Pole of a vigorous Load-Stone, and continue there for ſome time, the attractive Virtue is renew'd.

EXPERIMENT VII.

A Load-Stone that hath loſt it's attractive virtue by Ignition, will not acquire ſo durable an attractive Virtue, by being apply'd cold, as hot, to a Load-Stone.

N. B. Tho' ſeveral Load-Stones loſe their attractive Virtue by Ignition, yet the Obſervation does not hold in all; ſince *Engliſh* ones, not only retain a Directive, but an Attractive Virtue after it.

EXPERIMENT VIII.

HAving heated two Load-Stones red hot, and placed them upon a Plate of Silver, we found, that as they grew colder, it had a more ſenſible Operation on them.

EXPERIMENT IX.

WE obſerv'd, that one of the two Magnets juſt now mention'd, not only retain'd ſomething of it's Magnetical Qualities when twice ignited, but being thruſt into Filings of Steel,

Steel, carry'd a conſiderable Quantity of them up with it; which ſhews, how firmly the Qualities of ſome Magnets are lodg'd in it.

EXPERIMENT X.

BUT we obſerv'd, that the Magnet which would thus carry Filings of Steel along with it, being heated again, and ſuddenly immers'd in Water; when cool, would not carry Filings of Steel along with it, as before, nor would not move a well-pois'd Needle, except held near to the Point of it.

EXPERIMENT XI.

AN oblong Load-Stone of a black Colour, which weigh'd about three Drachms, by being kept ſome time in a Charcoal Fire, loſt much of it's Colour, and about $\frac{1}{8}$ of a Grain in Weight.

And to diſcover the Affinity betwixt a Load-Stone and Iron Ore, I took a Lump of it, which was almoſt like white Stone; and obſerv'd, that it did not only manifeſtly move a Needle, but when ignited, underwent a ſenſible Change in Colour, and would attract the *North* End of a Needle.

EXPERIMENT XII.

TO prove that ſome Bodies, not uſually claſs'd amongſt Magnetical ones, have nevertheleſs Magnetical Qualities, I ſhall ſubjoyn; That a Brick being divided into two oblong pieces,

and heated in the Fire, acquir'd a Verticity by cooling *North* and *South*, it's *Southward* End being in ſome meaſure able to draw the *North* Point of a Mariner's Needle, which the other End of the Brick would drive away.

EXPERIMENT XIII.

HAving without the help of Iron Inſtruments powder'd a black Load-Stone, and pour'd Spirit of Salt upon the fine Powder, it caus'd ſuch an Ebullition, as uſually ſucceeds the Effuſion of that Liquor upon Filings of Iron, and likewiſe rais'd fetid Fumes: And being kept for about two Nights in Digeſtion, extracted a ſtrong Tincture, being almoſt red, and not green, like that of *Mars*; yet would, like that of Iron, turn a Tincture of Galls black, which in ſeveral Poſitions would appear Blew. And to this I ſhall add, that a Solution of Load-Stones being made in *Aqua Regia*, the Tincture appear'd to be of a golden Colour.

EXPERIMENT XIV.

HAving powder'd an ignited Load-Stone, and digeſted Spirit of Salt upon it, it extracted a Tincture, which was much like that of troubled Gold, and would turn an Infuſion of Galls black: This Tincture being evaporated, would not ſhoot into Cryſtals, but upon an Affuſion of Salt of Tartar, yielded a Precipitate much reſembling a Solution of Vitriol, whereas another Part of it upon an Addition of Spirit of fer-

fermented Urine, afforded a yellowish red Precipitate.

EXPERIMENT XV.

HAving wet a red Mineral, (which I suspected to be Iron Ore,) with Linseed Oyl; and preserv'd the Powder in a red hot Crucible for about two hours, it was turn'd black; and when cool, had acquir'd a Magnetical Virtue, which another Portion of it did, tho' it was not as the other, wet with that Oyl.

CHAP. XXV.

Experiments and Notes about the Mechanical Origin and Production of Electricity.

Of the mechanical Production of Electricity.

THO' Electricity be a Quality, generally reckon'd amongst the Number of those that are term'd occult ones; yet there is no need to ascribe it to the power of a Substantial Form, since it may be mechanically produced by material *Effluviums*, issuing from, and returning to the Electrical Body, assisted in it's Operation by the External Air.

There are several Modern *Hypotheses* which endeavour to account for Electricity; as the Learned *Cabeus*'s, who supposes that, the Steams of the electrical Body discussing and expelling the ambient Air, that, when driven off, is violently oppos'd by the Atmospherical Air, and being driven back upon

the Body ſaid to be attracted, forces it up to the electrical Body.

Another *Hypotheſis*, propos'd by the Ingenious Sir *Kenelm Digby*, and embrac'd by Dr. *Brown* and ſeveral others; is, that the Electrick Body being rubb'd, emits unctuous Steams, which being cool'd by the External Air, ſhrink back, and carry along with them, thoſe light Bodies which lie in their way. Of this Opinion is *Gaſſendus*, who ſuppoſes theſe unctuous Steams to croſs each other, and by getting into the Pores of Straws and other attracted Bodies, take faſter hold of them, and when they ſhrink back, draw thoſe Bodies along with them.

Carteſius rejecting theſe Hypotheſes, ſupplants another, which I cannot in few Words lay down; but all the Reaſon he rejects them being, becauſe he ſuppoſes Glaſs incapable of emitting *Effluvia*; it will be ſufficient to remove that difficulty, to Obſerve, that if two Pieces of Glaſs be rubbed together, they emit odorous, and ſometimes very Stinking *Effluvia*.

But without taking any further Notice of what Moderns have laid down about Electricity, ſince they allow it to be performed by Virtue of ſubtle Emanations from the Attracting Body; It may ſuffice, that I proceed to mention ſome *Phenomena*, that make us probably believe it done by Virtue of Mechanical Affections, either of the Attracting Body, or both.

And *Firſt*, it is Obſerved, that moſt, if not all Electrical Bodies, attract not till warm'd; by which heat they are enabled to ſend forth *Effluvia*.

Se-

Secondly, Amber attracts moſt vigorouſly when warmed by rubbing and Chafing; by which Action, the Motion of the *Effluvia*, as well as of it's Internal Parts are more agreeably modified, than by the Action of Fire; but if the Parts of the Amber be firſt put into Motion by the Fire, and then Modifi'd by Chafing, it ſooner becomes Electrical.

Thirdly, Terſion, as well as Chafing, promotes Electricity, by removing thoſe Bodies, which might choak the Pores of the Amber, and obſtruct the Efflux of Emanations, by ſticking to the ſurface of it.

Fourthly, Electrical act not like thoſe more ſubtle Magnetical Steams, ſince the Operation of Electrical *Effluvia*, are obſtructed by the Interpoſition of a piece of the fineſt Linnen or Sarſnet.

Fifthly, Electrical *Effluvia* act leſs vigorouſly in Thick and Cloudy Weather, eſpecially, if the *South* Wind blows; and on the contrary they act likewiſe more faintly in the Night than in the Day.

Sixthly, Moſt Electrical Bodies are made of Matter, capable of emitting Odoriferous Steams by Heat and Attrition.

Seventhly, For which Reaſon, Bodies continue their Electrical virtues ſometimes after the attrition; the Commotion in the Parts of the Concrete, cauſed by that attrition, not immediately ceaſing.

Eighthly, To make it probable that Electrical *Effluvia* may inſinuate themſelves into the Pores of other Bodies, I ſhall add, that I found them ſubtle enough to attract Spirit of Wine, and alſo the Smoak of an extinguiſhed Wax-taper at a conſiderable diſtance.

Nimbly, The Electrical Virtue depends not on any Sympathy betwixt the Body Attracting and the Substance Attracted; since Amber indifferently draws to it all Bodies, which are not too gross, except Fire, by the violent Motion of whose parts, the Electrical Emanations are dissipated, and the Fire determined another way.

Tenthly, A vigorous and well excited piece of Amber will attract not only the Powder, but less minute Fragments of Amber; and the following Experiment may give us Reason to believe, that the Electrical *Effluvia* of the Attracting Body, not only fasten upon the Body to be drawn, but that the Cohereing Particles of the *Effluvia* make up viscous Strings, which intervening betwixt those two Bodies, when their agitation ceases, shrink inward, and are contracted; as a highly stretch'd Lute-string, when permitted to shorten it's Dimensions: The Experiment was this, *viz.* We suspended a piece of Amber by a Silken-thread, by the help of a piece of Wax, and then rubbing the Edge of it with a Pin-cushen covered with Course black Stuff, when it was well excited, and brought to settle, we observ'd, that if the Cushen was held near the excited Edges, the *Effluvia* would fasten upon it, so that when the Cushen was removed, the Amber would follow it several times for the space of ten or elven Minutes.

Electricity Mechanically produced and destroy'd.

But to proceed to what I promised in the Title of these Papers, I shall add some Experiments to shew, that Electricity may be Mechanically produc'd or destroyed.

EXPERIMENT I.

A Fourth Part of Good Turpentine being evaporated, the remaining ſubſtance hardened into an Electrical tranſparent Gum.

EXPERIMENT II.

THE dry Maſs which remain'd after a Diſtillation of *Petroleum* and ſtrong Spirit of Nitre, being a brittle ſubſtance like Jet, reſembled it in it's Electrical Quality.

EXPERIMENT III.

THE Tranſparent Glaſs made of Antimony burnt to Aſhes, had a conſiderable Degree of Electricity. Which is the more worthy our Notice, becauſe, that as a *Vitrum Antimonii*, which is accounted purer than ordinary, may be made of the *Regulus* of the ſame Mineral, (in whoſe preparation a great deal of Sulphur is ſeparated and left amongſt the *Scoriæ*) ſo Glaſs of Antimony made without Addition, may in part be reduc'd to a *Regulus* (a ſubſtance not looked upon to be Electrical:) Nor is ſome peculiar and fixed part of Antimony alone capable of Vitrification, ſince of the other Part, which uſually flies away, an Antimonial Glaſs may be made, without an Addition of other Ingredients.

EXPERIMENT IV.

I Once prepared a Glaſs of Lead *per ſe*, which had a Languid Electricity, and which would afford a Malleable Lead again, which is not in the leaſt Electrical.

EXPERIMENT V.

AMber being Diſtilled *per ſe*, the *Caput Mortuum* being quite burnt was black, and brittle, and not in the leaſt like Amber; yet tho' it's ſubſtantial Form was deſtroyed, it was more vigorouſly Electrical than Amber it ſelf; And as it appeared from the Inſtance of Glaſs of Antimony above, that the remaining ſubſtance may retain an Electricity, tho' the Form of the Body be deſtroyed, and part of it diſſipated; ſo from common Glaſs, we may Learn, that a compound ſubſtance may be Electrical, tho' the ſeparate Ingredients were not.

EXPERIMENT VI.

Electricity may be produc'd by unheeded and fortuitous Cauſes.

TO make it appear that Electricity may be cauſed by unheeded and fortuitous Cauſes, without depending on the ſubſtantial, or even Eſſential Form of the Attrahent, I ſhall ſubjoyn, that Locks of ſome Hair being brought to a certain degree of Dryneſs, by Curling or otherwiſe, have been obſerv'd to be attracted by the Fleſh of ſome Perſons, as Hair is wont to be by excited Amber; which they were more ſubject to do in Froſty Weather.

To

To try whether the Air was much concerned in Electricity, I ſuſpended a piece of Amber (which, when excited, would ſtir a poiſed Needle ½ of an Hour) in a ſmall Receiver, and when the Air was exhauſted, the Amber being let down near a Straw or Feather, attracted it in *Vacuo*.

EXPEREMENT VII.

TO ſhew that the Attraction of light Bodies, depends on very ſmall circumſtances, I made uſe of a Downy Feather taken off the Body of a Fowl, to which when it had been attracted by an excited piece of Amber, I applied the end of my Finger to it, upon which it ſtuck and left the Amber. The ſame ſucceſs I had, when the Experiment at diſtinct times was tryed with the Tip of a Silver Inſtrument, and Iron Key, and, a piece of black Poliſh'd Marble. We had the like ſucceſs, when the Experiment was tryed at ſeveral diſtant times afterwards. But one thing remarkable was, that if the Amber had loſt it's attractive virtue, before my Finger or the other Bodies were applyed, the Feather was not diſpoſed to ſtir, till the Amber was again excited.

To conclude theſe Notes, I ſhall advertiſe, that the event of Electrical Experiments is very uncertain, and varied by ſlight Circumſtances, ſome of which are altogether over-look'd, which in ſome Meaſure appears from the above recited Notes.

And therefore I ſhall add, that ſometimes it is very hard to know whether a Body be Electrical

cal or not; for, tho' *Kircher* denies Chrystal to have an attractive power; yet I have observ'd the contrary. And tho', the industrious *Gilbert* denies Electricity to Cornelians and Emeralds, yet all that I have try'd, had some Degree of it, except one Cornelian. And indeed Electricity is constantly inherent in Diamonds, so that it may be one good way to try whether they be Genuine, since most of them are considerably more attractive than common Glass. But to conclude, I shall add further, that rough Diamonds are Observ'd, to have a faculty of attracting much more eminently than Polish'd ones; for which no other Reason can be conceived, but that the Diamond in Polishing, being considerably, Heated by the Mill, several and a great part of it's Electrical *Effluvia* are spent and fly away.

CHAP. XXVI.

The General History of the Air *begun.*

TITLE I.

What we understand by Air.

BY Air, I mean, that thin, Diaphanous, fluid Body in which we Breath, which encompasses the Terraqueous Globe, and is capable of Rarefaction and Condensation; so different from *Æther* or *Vacuum*, that it refracts the Rays of the Moon as well as other Remoter Luminaries.

TITLE

TITLE II.

Of the conſtant and permanent Ingredients of the Air.

BY Air, I would not be thought to mean, ſuch Artificial and *Temporary* Air as uſually flows out of an Æolipile, when one that is furniſhed with Water is expoſed to a ſufficient Heat, and then condenſes into Water again; but common Air, which is *Permanent*, and continues in that Form; Which I conceive, is made up of three kinds of Particles. The firſt are *Effluvia*, from ſeveral ſubſtances belonging to the Terraqueous Globe: The Second are the Magnetical Steams of the Earth, and Sydereal Emanations: The Third are theſe Elaſtick and Springy Parts of the Air which are *Permanently* ſo. *Of the Nature of the* Air.

As for the Structure of theſe Elaſtick Parts, they may be conceiv'd different as Mens contrivances deviſe to anſwer Particular *Phænomena*: One may think them like the Spring of a Watch; others like a Fleece of compreſs'd Wool, endeavouring always to expand themſelves; others, like Curl'd pieces of Wire, of different Lengths and Thickneſs, and diverſified by being more or leſs Curl'd: All of which may be capable of being compreſſed and expanded again, by virtue of their Native Structure, Heat, Girations and other Motions. I have likewiſe compar'd 'em to thin ſhavings of Wood, which are of different Sizes; and this compariſon may in ſome Meaſure

ſure Illuſtrate their Generation, there being no Art requiſite to the production of ſuch, nor curious Inſtruments; and yet their Curls are very different and ſeemingly Caſual; as alſo their ſpringneſs depends on their convenient ſhape. And the Generation of Air may be further illuſtrated, by obſerving, that theſe ſpringy Chips may be made of the Parts of Beams and Blocks, not at all Elaſtical before. Which favours an Experiment I made, wherein, by the Action of a *Menſtuum* upon a Mineral Body, a quantity of Fire was Generated, *permanently* Elaſtick.

But not to multiply Conjectures about the Structure of the Parts of the Air, I ſhall add, that, tho' their Elaſticity ſeems to depend on their Structure; yet it may be encreaſed, by quickening their Motion by the Action of Fire; Beſides, there may be ſeveral Elaſtick Parts in Air, whoſe Elaſticity may rather depend on their Motion, than Figure, they being, thereby enabled to ſtrike againſt Bodies about them, and to keep them off. And not improbably in theſe warmer Climates, the parts of *Temporary* and Artificial Air may be put into ſuch Motion, as may for the time keep it fluid; thoſe parts of Matter being diſpos'd to be kept in Motion.

TITLE III

Of the Æther *in the* Atmoſphere.

TITLE IV:

Of the ſpungy Particles of the Air, and the the Spring of the Air.

Follibus luſoriis aerem pyulico ingerentes majorem ſubinde atq; majorem difficultatem percipiunt; quo enim magis Aer concluſus naturali ruritate recedere cogitur; etiam majore niſu reſiſtit, neq; ſolum magis denſari renuit, ſed & ſe latius explicare molitur. Hinc didicimus & pneumatico fontes conſtruere, qui Spiritu interno urgente aquam in altum evibrant, & plumbeas Glandes fiſtulis ejaculari, non pulvere nitrato ignem concipiente, ſed aere per vim denſato ad antiquas dimenſiones recuperandas erumpente. Quoniam verò ingeſta jam in conceptaculum non exigua aeris copia difficilius comprimitur novâ aeris acceſſione; quam ut manus valeat truſillum recta impellere, idcircò truſilli haſtulam deformatam in helicem, & ſua Matrici inſertam, adhibere oper pretium erit, dum enim manubio agitante contorquetur Cochlea, ſenſim deprimitur Embolus, aeremq; ingerit. Ne autem mora longiore opus ſit perpetua verſatione Manubrii, ita Cochleæ Matrix externam vaſis faciem contingat, ut illi adnecti, atq; ab eo diſjungi valeat: initio enim, quando adhuc levis eſt aeris modice compreſſi reſiſtentia, lamella illa ſuo feramine interius claviculatim ſtriato coharens ha-

Aerem valide comprimere aut dilatare.

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haſtula emboli, ſi à vaſe disjuncta fuerit unà cum haſtula movebitur: deinde verò, quando jam transillis agrè impellitur, lamilla illa cum Vaſe connectatur, & non niſi verſato Manubrio adduci atq; reduci Embolus poterit, id quod ſatis lèmè perficietur: Rem claritatis Gratia in fonte Pneumatico explicemus.

Sit vas A. B. *ex materia Metallica, in cujus ſuperiore parte labrum, ex quo perforamen* A. *immittatur in vas aqua, ita tamen, ut non impleatur; aqua enim in vas modice inclinatum deſcendens, aerem expellet per Tubulum* C. D. *ubi ſatis Aquæ immiſſum fuerit, occludatur foramen* A. *diligentiſſime Cochleola congruente & convoluto Epiſtomio* E. *Tubus* D. C. *ſit Aeri impervius ad vaſis latus ſtatuatur modiolus cum embolo congruente* H. I. *& emboli haſtula ſit connexa cum mobili vaſi anſa,* H. O.

Porro haſtula H. K. *perforata ſit, & continuo ductu uſq; ad emboli* K. F. *fundum pateat Aeri ingredienti via* H. S. *ſed foramini* S. *adjecta ſit Valvula, quæ Aeri regreſſum obſtruat. Similiter modioli fundo in* I. *Valvula exterius appoſita aperiatur ingeſto Aeri tranſitum præbens; ſed Aeri intra vas compreſſo cum nuſquam exitus pateat, Valvula ipſa modioli foramen* I. *occludit. Haſtula verò* H. K. *exterior facies ſit in helicem ſtriata, & lamellæ* M. N. *tanquam Matrici congruat, quæ in* M *&* N. *Cochleolis adnecti queat exterius vaſi, quaſi eſſet anſa fulcrum.*

Ubi immiſſum fuerit quantum ſatis eſt aquæ, Cochleolis M *&* N. *revolutis disjungatur Matrix à va-*

à vase: tum attractâ ansâ H. O. *una cum Lamella* M. N. *attrahitur embolus* K. S. *& per apertum ductum* H. S. *ingreditur Aer, modiolum implens. Impulso deinde Embolo, Valvula ad* S. *clauditur, & Aer ex modiolo, per patentem Valvulam* I. *ingreditur in Vas; ex quo nequit exire, neq; aquam propellere, clauso scilicet Epistomio & foramine* A. *quapropter comprimitur, & densatur; ideoq; attracto denuo Embolo* K. S. *inclusus vasi Aer se latius explicare connitens Valvulam* L. F. *valide applicat foramini modioli, sibiq; exitum obstruit. Toties adducitur atq; reducitur Embolus, & Aer ingeritur, quoad magna premendi difficultas percipiatur; ubi eo ventum fuerit, tunc Lamella* M. N. *iterum vasi adnectatur suis Cochleosis; nec jam Embolus recta adduci queat; sed arreptum in* O. *manubrium versatur, & Embolus intra modiolum circumactus sensim attollitur, qui deinde revoluto in contrarium Manubrio deprimitur, & multa vi Aer in vase comprimitur. Laxato demum Epistomio* E. *compressus in vase Aer, aquam exprimit per Tubum* C. D. *primum quidem vehementius, subinde remissius, prout Aeris vis elastica sensim conquescit.*

Hoc idem quod de Aere intra Vas comprimendo ad aquam evibrandum comminisci placuit, servatâ analogiâ, dicendum est de Aere, tum conatu manûs rectâ trusillum impellentis, tum ope Cochleæ similiter conformatæ, intra conceptaculum comprimendo, ut ex fistula deinde multa vi emittatur plumbea Glans, ubi reseratus Aeri exitus illum subito dilatari permiserit. Quin & Pneumatica hujusmodi tormenta citra conceptaculum Aeris compressi construere non inmile accidat, si, quemadmodum nostrates pueri surculos sambuceos fungosa medulla exhauriunt, & utraq;

Tubuli

Tubuli extremitate papyraceis Globulis obstructa, alterum Globulum congruo Cylindro propellunt, aut, inclusum Aerem densant, quoad Aeris vim elasticam, & impellentis manus Conatum, non ferens extremus alter Globulus edito scloppo expellatur; ita ferream fistulam longiorem paraveris, cujus alteri extremitati immittatur plumbea Glans, obducta papyro, aut simili Materia, ut exquisitè Tubi osculum implens, demum universam Aeris vim excipiat, alteram extremitatem aliquot Spiris ambiat cava Cochlea, quam impleat Cylindrus ferreus in congruentem Cochleam deformatus; si enim hujusmodi Cylindrus, vis brevior fuerit, quam fistula, & aqua Manubrio convolutus, in fistulam sensim immittatur, totum Aerem, quo fistula replebatur, ad exiguum spatii angustias adiget, ex quibus magna vi demum, qua data porta, erumpens, ejaculabitur plumbeum Globulum Casati Mechanicorum, Lib. 8. Cap. 5. p. 792. 793. &c.

TITTLE V.

Of the Magnetical Particles in the Air.

TITLE VI.

Of the Destruction, Generation, Absorption and Extrication of the Air.

Concerning the Production of the Air.

AIr being a body not only concern'd in a great many *Phenomena* of Nature, but likewise so necessary to the Preservation of Animals; Is thought

thought it of no ſmall uſe to try whether it might be Artificially prepar'd and obtain'd from Bodies which ſeem'd not at all to abound with Air; for could it be done, it would not only be conſiderable in helping to explain ſeveral *Phænomena* of Nature, but to preſerve *Divers* much longer under Water. To try therefore whether it might be effected, and whether that which ſeem'd to be Air, were truly ſo; I made uſe of the following Experiments, taking a durable Springineſs or Elaſticity as the *Criterion*, by which I ſhould judge, whether the Air generated were Genuine or not.

EXPERIMENT I.

Jan. 17.

Air generated by a mixture of Oyl of Vitriol and Filings of Steel.

Fillings of Steel, and a conveniently ſhap'd Glaſs, which contain'd Oyl of Vitriol, and was ſeal'd at both Ends, but with a Hole open'd near one of them, were coveigh'd into a long and large Tube, ſo much Water being put in with them as was ſufficient to dilute the Oyl. This being done, and the External Tube and the Water exhauſted, till the Mercury in the Gage was ſo far rais'd in the open Leg, that little remain'd in the ſeal'd Leg; we clos'd up the External Tube exactly, and obſerv'd, that when the Oyl was caus'd to run out of the internal Tube, by acting upon the Metal it caus'd ſeveral Bubbles, and a ſenſible Heat; when this Conflict had continu'd ſome time, ſo much Air was generated, as depreſs'd the Mercury in the open Leg down to the Bottom; and rais'd it ſo much in the other, that the Air above it was more

compreſs'd, than when the *Atmoſphere* had free Liberty to preſs againſt it. The Spring of this newly produc'd Air was ſo ſtrong and durable, as to keep the Mercury at the ſame height 3 or 4 Days; and ſome Days after, a Boy having heedleſly remov'd the Tube from its uſual Station, the Mercury in the Gage aſcended an Inch and a half, at which Height it continu'd till the 25th of *January*.

EXPERIMENT II.

March. 8.

Flower moiſten'd with Water.

A Glaſs Viol, which was large enough to hold a Pint, was fill'd with Flower of Wheat drench'd with Water; and the Orifice being clos'd with a Cork and ſtrong Cement, after the Glaſs had been placed 13 Days in a warm Place, it was burſt by the Violent expanſion of the included Matter, tho' the Night before, part of the Glaſs below ſeem'd empty. The Taſte of the included Matter ſeem'd to me only a little ſowriſh; but to another manifeſtly acid.

EXPERIMENT III.

March 9.

Raiſins included in Vacuo with Water.

BRuiſed Raiſins with a little Water being put into a Bolt-head; when it was exhauſted, I plac'd it in a warm Place. In four Days no Air was generated; but ſome time after the Bolt-head was burſt in pieces, and the Raiſins thrown about.

EX.

EXPERIMENT IV.

Feb. 22.

A Glaſs, which would hold about 3 Pound of Water, having a ſufficient Quantity of Raiſins put into the Water, a Bladder was ty'd to the Neck of it, which had all the Air ſqueez'd out, and, in two Days time, it was ſo fill'd with Air, that we could not tye it up, without loſing ſome of the Water.

EXPERIMENT V.

April 28.

SPirit of Salt, and Filings of Steel, being put into a wide mouth'd Glaſs, we cover'd it with a Receiver, fitted with an Eel-Skin and a Wire, to the latter of which, a thin Glaſs Veſſel was ty'd, hermetically ſeal'd at the Bottom, and furniſh'd with a ſufficient Quantity of Filings of Copper. This being done, and the Receiver exhauſted, we thruſt the Glaſs which contain'd the Filings againſt the Bottom of the Viol, and broke it off; whereupon the Filings falling into the *Menſtruum*, a conſiderable number of Bubbles were generated. The Viol being kept ¼ of an Hour longer in *Vacuo*, the Liquor acquir'd not the leaſt Greenneſs.

EXPERIMENT VI.

Air ſhut up in Oyl of Turpentine and Spring Water.

A Bubble of Air about the Size of a Pea, being left at the Top of a round Viol with a long narrow Neck, the Cavity of it being fill'd

with fine Oyl of Turpentine, and then inverted into a Viol fill'd with the ſame Liquor; Another Viol which had a Bubble in the Top, was fill'd with Alcohol of Wine, and inverted it into the the ſame Liquor. On the ſixth Day the Bubble in the Oyl diſappear'd, and on the ſeventh, that in the Spirit of Wine vaniſh'd.

EXPERIMENT VII.

May 23.

Frog's Spawn. A Receiver, which had been three Years exhauſted, was open'd; and a black opacous Liquor, which we judg'd to be Frog's Spawn, which was contain'd in a Viol, being taken out, was of a ſtinking Smell, but not mouldy. It had yielded ſome Air.

EXPERIMENT VIII.

IT is obſerv'd, that when Miners meet with running Waters under Ground, they are by thoſe, ſupply'd with Air enough for Reſpiration; tho' it is obſerv'd, that ſtanding Waters do not afford Air.

Experiments about the Production of Air, and the Examining thereof propos'd.

Sect. I. To produce Air by Fermentation in Receivers exactly clos'd; and in ſeal'd Glaſſes.

To ſeparate Air from Liquors, by boyling; or by the Engin.

To

To obtain Air by Corroſion, eſpecially with Spirit of Vinegar.

To ſeparate Air by Sulphureous and Animal *Menſtruums.*

To produce Air in *Vacuo* by Burning-Glaſſes and hot Irons.

To obtain Air from Gun-powder, and other nitrous Subſtances.

Sect. II. The Air produc'd may be examin'd, by trying whether it will Preſerve or Revive. 1. Animals. 2. Flame. 3. Fire. 4. The Light of Rotten Wood, Fiſh.

To examine it's Spring, and the Duration of it, as alſo it's Weight, and whether it will help to raiſe the ſmoak of Liquors.

TITLE VII.

Of the Accidental or leſs conſtant Ingredients of the Air.

TITLE VIII.

Of Aqueous Particles in the Air, and of it's Moiſture and Dryneſs.

Of the Air's Moiſture and Dryneſs.

THO' Dryneſs be a Quality which only depends on this, *viz.* That the Pores intercepted betwixt the ſtable Parts of a Body, are not fill'd with any viſible Liquor; yet it hath a conſiderable Intereſt in the Changes of Bodies upon different Scores. *Firſt*, In as much as the

Body dry'd is depriv'd of Liquid Parts, upon the Effects of which, ſeveral of it's Operations depend. *Secondly*, Upon the Receſs of thoſe Parts evaporated, the Texture of the Body may be ſo far chang'd, as to acquire a diſpoſition to act otherwiſe, and to be acted on in a different manner to what it was before.

EXPERIMENT I.

TO evince the Efficacy of the Air's Moiſture, we ſuſpended a Quarter of a hundred Weight by an Iron Ring at the End of a Rope, which was about 3 Foot and a half long, and $\frac{1}{16}$ of an Inch in Diameter; and when the Weight had ſtretch'd the Rope for 2 or 3 Days, we plac'd a Board under it, ſo that it might juſt reſt upon it, and then cauſing the Rope to be wet, in about half an hour it ſhorten'd ſo much, that the Weight would ſwing this way, and that, like a *Pendulum* without touching the Board; yet the ſame Day the Rope was ſtretch'd again, ſo that it touch'd the Board.

About *Morocco*, which is an Inland Town, tho' the Soil be dry, and the Heat violent in the Day; yet I am told by one who was there, that the Nocturnal Air was ſo damp, as to be able to make his Cloaths unfit to be worn, till Air'd; yet, tho' the Air was very piercing, neither the Knife in his Pocket, nor the Sword in his Scabbard were ſubject to ruſt, tho' the ſame Metal expos'd to the open Air, was.

Air too moiſt cannot be wholſom. The Air about *Oakly* and *Brill* in *Buckinghamſhire*, tho' a high Country, is ſo moiſt in *October*, that the Stair-

Stair-Caſes and Pictures will ſtand all over Dew, which gathering in drops, runs down in Streams; and it is obſer'd, that the *North* and *North-Eaſt* ſide of the Houſes are ſo moiſt, that except the Rooms be air'd often, the Furniture will rot.

Having made uſe of a Hydroſcope which was made of a Box, to whoſe Bottom a piece of Gut-ſtring was faſtend, and the other End of it to an Index, which lay upon the Top of the Box, the Circumference of the Box was divided into Degrees, or Partitions; By which we could perceive, that when Moiſt Vapours inſinuated themſelves into the Pores of the Lute-ſtring, it would be wreath'd and twiſted up, and the Index would be mov'd that way, which the twiſting of the Rope inclin'd it, and when the Weather was dryer, it would return back the other way.

EXPERIMENT II.

ONE of theſe Hygroſcopes being conveigh'd into a ſmall Receiver, when the Air was exhauſted, the Index did not ſenſibly alter it's Place in a long time; till the External Air was let in again. From which Experiment, and ſome others try'd with a Thermoſcope, it appears, that the *Æther*, or that ſubtle Matter which ſucceeds in the Place of the exhauſted Air, is neither hot, cold, moiſt, nor dry.

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TITLE IX.

Of Clouds, Mists and Fogs.

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AN excellent Astronomer told me, that of all the white Clouds, whose Height he had measur'd in fair Weather, he found none to exceed ¾ Quart. of a Mile; and very few above ½ a Mile.

A Mist at Sea driving towards the Shoar, without any sensible Wind, causes the Sea to swell more than a brisk Wind. It hath likewise been observ'd, that Mists in some places rising about 30 Foot high, have fallen down in a Dew again.

TITLE X.

Of Terrestrial Steams in the Air.

Of Terrestrial Effluvia.

PIllars of Fumes have been divers times observ'd to rise from Ground which had several Veins of different Metal in it, some ill scented, some well scented, and others inodorous; and I have observ'd, that the Charcoal made in *Cornwall* affords a manifest Arsenical and Sulphureous Smell beyond other Charcoal.

Journal des Savans, Jul. 1685.

'Tel est par exemple ce nuage horrible d'une 'fumée epaisse qui s'eleva de la mer de Cretec au 'Commençement de l'Eestede l'an, 721. et 'qui

'qui s'etant repandu dans l'air le fit paroiſtre 'tout en feu. La mer n'en fut pas meſme ex- 'empte, car les groſſes Maſſes de pierres enflam- 'mées qu'on en vit ſortier, et qui ſe joignirent 'al'Iſle qu'on Nomme *Hiera*, échauferent ſi fort 'les eaux qu'elles en bruloient les maines.

TITLE XI.

Of Salts in the Air.

Of the Salts in the Air.

THO' the Peripateticks teach, that the Air is an Element, and conſequently a pure ſimple Body, whoſe Qualities are moiſt and dry; yet from what we have already deliver'd, it appears, that it is an Aggregate of various kind of *Effluvia* jumbled and mix'd together; I mean, the Air diſtinct from that Purer Subſtance *Æther*, which I ſuppoſe diffus'd through the Interſtellar Part of the Univerſe.

Amongſt the *Effluvia* which rove up and down the Air; I account Saline ones the Chief, which is not unlikely, ſince the Terraqueous Globe, which continually emits *Effluvia*, abounds with great Quantities of Marine, Aluminous and Vitriolate Salts, which impregnate the Air; beſides ſeveral Exhalations rais'd by the Sun-Beams, from the Surface of the Earth and Water; not to mention ſeveral other Saline Vapours which are diſperſed in the *Atmoſphere*, and ariſe from *Vulcanos*, as well as common Fires,

And

And as it is not improbable, but that the Air plentifully abounds with Saline *Effluvia*; so very likely, besides Nitrous, there are other kinds raised up and roving about in it; as Common Salt, and Vitriolate Salts; and that which seems to prove, that the Air in some places abounds with vitriolate Salts, is, that it hath been observ'd, that Hinges have been corroded and rotted, and other things prejudic'd upon a Vitriolate Soil, whereas in Houses, which stood on a *Chalky* Soil, no such Effects were observ'd: Besides, on the Vitriolate Ground, we took Notice of Saline and White Efflorescences upon the Surface of the Soil, when beaten upon by the Sun-beams.

Besides which kinds of Salt, I am induc'd to believe, that the Air abounds with Volatile ones; For besides, that an Acquaintaince of Mine obtained a Spirit and Salt of Similar Qualities with Spirit of *Harts-horn* from Earth dug up some Yards deep; we may observe in favour of what I propose, that the very Soot which rises from fires near great Towns, a great part of which is dispersed in the Air, abounds with a Saline Spirit, which may be obtain'd from it by Distillation; as likewise, a great quantity of Volatile Matter may be raised in the form of Vapours from Animal substances putrified and corrupted.

But besides these more simple Salts, there may be several others compounded in the Air, which may result from several Coalitions of simple Salts; and several Compound Salts may, not unlikely, arise from Subterraneal Parts: In favour of which I shall add, that in

America

America the *Effluvia* of a *Vulcano*, not only offended the Faces of ſome that approach'd too near, but cauſed a manifeſt alteration in the Colour of their Hair. And it hath been obſerv'd that ſeveral Sulphureous Exhalations have been gathered about the Crannies of *Mount Veſuvius*, which iſſuing out of ſmall Crannies ſtick to the Edges like Flower of Brimſtone: To which I ſhall add, that I had a Stone brought me from another *Vulcano*, whoſe Pores were full of a White Salt compounded of a fixed one, and another Volatile much like *Sal-Armon.*

The Salts we have hitherto taken Notice of, are ſuch as may be referred to a determinate Species: But I am apt to believe, that there are others which are ſuch as are not known, nor have they any Names given them; this appears from what we have elſewhere taught of Subterraneal Fumes; and may be further illuſtrated, by intimating, that I have obſerv'd Old Glaſs-windows ſometimes corroded, as if Worm-eaten; which probably proceeded from ſome corroſive Particles carried thither by the Wind.

As for the Nature of theſe ſeveral Salts, that at different times, and in various Places, impregnate the Air, amongſt the different Methods that might be taken to inveſtigate them, I ſhall mention the following.

Several ways to diſcover the Nature of the Salts *in the* Air.

Firſt, We may expoſe ſuch Bodies to the Air, as we think will moſt likely be work'd upon, by the Salt we judge Predominant in that place; as Lime, where we think Nitre abounds; as alſo we may hang up Silks of ſuch Colours as Nitre is moſt apt to fade, or diſcolour. In places

places where we think Vitriol abounds we may expoſe Preparations of Sulphur, which it uſually turns Black: In other Places we may ſpread White Linnen Cloths, and obſerve what Salts they imbibe along with the Riſing Vapours and Falling Dew.

A Second way to diſcover the Nature of the Salts in the Air may be, by expoſing ſome Body, which ſeveral Salts have different Effects on.

EXPERIMENT I.

CLean Copper Plates being placed over Glaſſes, under which, Spirit of Salt and Spirit of Nitre diluted with Water, were ſet. I Obſerved, that they were diſcoloured alike by the aſcending Fumes; it being common for theſe Spirits to draw a green Tincture from Copper as Spirit of Soot and Urine do a Blew one. I have obſerved a piece of Copper brought from a Mine overcaſt in ſeveral Parts with a Verdigreaſe, which effect I judged to depend on the Efficacy of ſome *Effluvia* in the Air. And poſſibly with other Bodies, diſcovering different diſcolourations, we be enabled to learn what kind of Steams thoſe Effects are produced by. And it hath been obſerv'd, not only at *Amſterdam*, but elſewhere, that Plate, in a little time, in thoſe Airs, would acquire a Ruſty Colour, or one partaking of Yellow and Black.

A Third way, which may be taken to diſcover the different Nature of *Effluvia*, may be by

by expoſing Preparations of Mineral Bodies, whoſe Colours are apt to be changed by the Air.

EXPERIMENT II.

IF a Solution of Silver in *Aq. Fortis* be precipitated with Spirit of Sea Salt, the Powder will be at the Firſt White; but after a while being expoſed to the Air, the Surface of the Liquor will acquire a dark Colour, which may perhaps vary as the Air is differently impregnated.

EXPERIMENT III.

AN equal Weight of Filings of Copper and Powdered *Sal Armoniack*, being mixed and put into a Covered Crucible, and kept over a moderate Fire till the *Sal Armon.* had done Smoaking, as much of the remaing Maſs as could be parted was taken out, and looked of a Dark Colour; but being groſsly beaten and expoſed to the Air, looked like Verdigreaſe, a ſubſtance whoſe Colour commonly varies, according to the Nature of the Salts concerned in the production of the Pigment. But a Parcel of the ſame Maſs being groſly beaten, and Hermetically Sealed up from the Air, and left in a *South* Window, was not diſcoloured when that expoſed to the Air, had acquired a Virdigreaſe Colour.

EXPERIMENT. IV.

SPirit of Soot of Wood diſſolved Copper into a lovely Azure; but the ſubſtance growing dry in the Air, changed it's Ceruleous for a Cyanious Colour, ſuch as may be ſeen in good Turquoiſes. Which Change depended not on the Saline-Sulphureous Salt. Which I rather believe, becauſe I had the ſame ſucceſs when I made uſe of an Urinous Spirit drawn from an Animal ſubſtance.

Moſt of the Inland Parts of our Country abound not with Corroſive Vapours, the Bars of Iron being not ſo ſubject to be corroded and Ruſt; So that I believe this Salt may proceed from Sea Vapours, or a diſſolution of ſome Corroding Salt, upon the burning of a Sea, or Mineral Coals.

Agricola de re Metal. Lib. 12.

Mox ollam ex igni removent; poſtea ex refrigerata eximunt halinitrum puriſſimum: quod candidi marmoris ſpeciem gerit; atq; tunc etiam id quod terrenum eſt, in fundo reſidet. At terra, ex qua dilutum fuit factum, & Rami quernei vel conſimilis Arboris alternis ſub dio ponantur, & aqua quâ combibis halinitrum conſpergantur: quo modo quinq; vel ſex annis rurſus apta ſit ad conficiendum dilutum. Halinitrum quodammodo purum, quod dum terra ter annos quievit interea, ortum fuit, & quod lapideæ parietes in Cellis Urinariis & locis opacis exudant, cum primo diluto permiſtum decoquatur.

Si verò locus aliquis talium venarum, copiam ſuppeditaverit, ipſa ſtatim non conjiciantur in caſt ella; ſed

ſed primò convehantur in areas, atq; cumulentur: quanto enim diutius aeri & pluviis expoſitæ fuerint tanto meliores fiunt. Nam in ejuſmodi cumulis, aliquot poſt Menſibus, quam Venæ in areas fuerint conjectæ, naſcuntur fibræ longe venis bunitate præſtantes: deinde vehantur in ſex, plurave Caſtella longa & lata ad novem pedes, ad quinq; alta.

Si verò dum dilutum recoquitur, ſeperata non fuerint, mox ex minoribus Vaſis infundatur in Majora, eaq; concludantur; in quibus item atramentum ſutorium ſeperatum ab alumine concreſcit utrumq; ineiſum & in Hypocauſto ſiccatum divendatur dilutum, quod in vaſis & cupis non concrevit in cortinam, refuſum recoquatur: ſed verra, quæ in fundo cujuſq; cortinæ reſedit, ablata in caſtella unà cum verra; denuo aqua & urina dilutatur. At terra quæ in Caſtellis dilata, poſtquam effluxit, ſuperfuit egeſta & coacervata quotidie, rurſus magis ac magis fit aluminoſa, non aliter atq; terra, ex qua halinitrum fuit confectum, ſuo ſucco plenior fit: quare denuo in Caſtella conjicitur, & aquæ effuſæ ea percolantur.

And I have not only been informed, that the Dews in the moſt *Southern* parts are more than ordinary Corroſive; but that in *Baſil* they are ſo Eſurient, that the *Portugals* are forc'd to keep their great Guns caſed up; in which Country the ſame Perſon told me the very Mony was corroded by the ſharpneſs of the Air; and he likewiſe obſerved, that the Dew left a White Salt upon the Graſs, which looked like a Hoar Froſt.

And I am likewiſe inform'd by a Native of the Place, that in a Town call'd *Fahlure* in *Sweedland*, which

which ſtands upon the bottom of a Hill, which hath a Copper Mine in it, The Exhalations are ſo powerful as to Corrode Iron and Braſs, and even Money it ſelf, tho' lock'd up in Cheſts of Wood an Inch thick.

TITLE XII.

Of Sulphur and Inflammable Particles in the Air; *and of* Lightning, *and it's Effect.*

Of Sulphur and Inflammable Matter, &c.

A Neopolitan Lord told me, that Riding upon Sulphureous Ground, the Horſes Feet would raiſe a Duſt, which would be ready to take Fire; and when purpoſely, he had cauſed ſeveral pieces of that Earth to be cut like Turffs, and to be laid in a heap, in the Night, the Steams which plentifully roſe from them, would ſometimes take Flame; And the ſame Lord told me, that near *Mons Veſuvius*, He obſerv'd the Flame ſo violent, than when Meaſured by a Quardrant, it appeared to be near two Miles high above the Top of the Mountain, and that great Flakes of Fire were thrown up into the Air as big as the Room we talked in.

Voyage de Levant. page 203.

'Voila tout ce qu' on peut dire cette *Iſle*, 'qui ſemple un enfer car on voit la mer du 'port, & de la coſte toute noire & brûlee d'un 'petit eſcuel, qui paroiſt depuis environ ſoixante ans, & d'ou on vit ſortir en ce temps la une 'grande

grande flamme, qui is a laiſſe une ouverture ſi profonde, que ſi on y jette une pierre, on ne l' entend point tomber. Mais ce qui eſt arrive depuis en ce port, n'eſt pas moins eſtonnant; je le rapporteray icy comme je l'ay appris de diverſes perſonnes en pluſieurs endroits. Il y a environ 18 ans que durant la nuit d'un certain Diamanche, commenca dans le port de Santorini un tres grand bruit lequel s' entendit jusques à Chio, qui en eſt eloigne deplus de deux cent milles, mais de telle ſorte qu' on crut a Chio que c' eſtoi l' armèe venitienne qui combatroit contre celle des Turcs, ce qui fit que dès le matin chacum monta aux lieux les plus elevez pour en eſtre Spectateur, & me ſouviens que le Reverend *Pere Bernard* ſuperieur des Capucins de Chio, homme Venerable, & tres digne de foy, me conta qu'il y avoit eſte trompè comme les autres, car il crut auſsi bien qu' eux eux entendre pleuſieurs coups de canon; cependent ils ne virent rien, & en effect ce fut un feu qui ſeprit dans la terre du fond du port de Santorini, & y fit un tel effect, que depuis le matin juſqu' au ſoir il ſortit du fond de la mer quantite de pierres de ponce, qui montient en haut avec tant de roideur & tant de bruit, qu' on euſt dit que ce fuſſet autant de caups de canon, & cela infecta tellement l'air, que dans la dite Iſlle de Santorini, il maurut quantite de perſonnes, & pluſieurs de la Meſine Iſle en perdirent la veue, qu' ils recouvrerent pourtans quelque jours apres. Cette infection s' eſtendit auſi loin que le bruit qui l'avoit precede, car non ſeulement dans cette Iſle, mais meſme a Chio, & a Smyrne, tout l'argent devint rouge,

ſoit qu' il fut dans les Coffres, ou dans les poches; & nos Religieux demeurans en ces lieux là me dirent que tous leurs calices en eſtoient devenus rouges. Au bout de quelques jours cette Infection ſe diſſipa, & l' Argent reprit ſa premiere couleur, les pierres de ponce qui ſortirent de la couvrirent tellement la mer del' Archipel, que durant quelque temps, quand il Regnoit de certains Vents, il y avoit des ports, qui en eſtoient bouchez, en façon qu' il n'en pouvoit ſortir aucune barque, pour petite qu' elle fut, que ceux qui eſtoient dedans ne ſe fiſſent le Chemin au travers de ces pierres de ponce avec quelques pieux; & on en voit encor a preſent par toute la mer Mediterranée mais en petite Quantite, cela s' eſtant diſperſé ca et la. Seneque raconte en une de ſes Epiſtres que Santonini eſt baſtte ſur des mines de ſoufre, & ce ſont elles qui fourniſſent aſſeurement la matiere pour allumer en cet endroit, & n'y trouva point de fond. Il y a pourtant une petite Iſle appellée Fireſiá, á la pointe de laquelle, on peut donner fonds, & point en aucun autre endroit.

It is uſually obſerv'd, that there is a ſtrong ſmell of Sulphur near where a Thunder-bolt falls. When I was near the Lake of *Geneva* call'd *Lacus Lemanus*, there was a terrible Storm of Thunder, and the next day ſo ſtrong a ſmell of Sulphur, that a Souldier who ſtood near the Place where a Thunder-bolt fell into the Water, could ſcarce bear the ſmell of the Sulphur.

July 24. 81. A Ship being at Sea about 100 Leagues off *Cape Cod* in 48 Latitude about 3 *P. M.* after a violent Storm of Thunder, the Bituminous Matter fell upon the Stem of the Ship, and burnt there, emitting a ſtrong Sulphureous Smell; and what was very remarkable, was that when Night came, they found, that the *North* Point of the Compaſs was become the *South* Point, and *vice versâ*. And,

It was obſerved by a very famous Planter, that ſeveral Trees remote from one another, had very long and remarkable fiſſures in the Bark, upon great Storms of Lightning.

TITLE XIII.

Of Electrical Influences or Effluviums in the Air.

SIR,

IN order to diſcover the ſeveral affections of Winy Liquors, and the ſeveral Diſtempers incident to them; and how to preſerve them, it is requiſite to conſider the Qualities of the Air, it's Temperature and Motion. *Celeſtical Effluvia in the Air*

And this puts me in mind to beg our Friends Aſſiſtance, who would do well to make ſome progreſs in perfecting the Theory of the Planets; for if that be not clear, we cannot be free from Errors in reſpect of their Motions and Calculations; and if we be miſtaken in theſe, 'tis impoſſible to know either their Places in the Heavens or their Aſpects, and conſequently the Phi-

sical way of their Motion must be uncertain, and of no use or advantage.

But, tho' by some they are looked upon to have little or no influence upon our Globe, yet all the Arguments alledged against that Opinion, are rather levelled against Astronomy, in Relation to some Superstitions about this Doctrine, than that they shew, why, when the Rays of each make different Angles upon one another, they may not at the last affect us. Since that they do is evident, by undeniable Experiments, not only on inanimate and vegetative Bodies; but likewise from the Observations of Physitians in all Lunatick, Epileptick, Paralitick or Lethargick Persons.

And indeed, since Rarefaction and Condensation are mediate Motions, which dispose Bodies to Corruption, and are assisting in Generating New ones; and, since all the Affections and dispositions of Moisture, Heat, Cold, Drought, the Course of all Winds, Showers, Thundering, or whatsoever else is used by Nature, to produce these two General Effects of Rarefaction and Condensation, do in a great Measure, if not wholly depend upon, and are altogether regulated by the Course and Aspects of the Celestial Bodies, it will not be irrational to teach, that every one of those, emitting Rays peculiar to themselves have, by the Influence of those, different Effects on our *Atmosphere*: The subtle parts of the Air being not only subject to be worked upon by them, but likewise our Spirits, and other Humours, whose Parts, by the impression of these subtle Rays, may acquire a new determinate Motion, and consequently be altered, whence

whence may arise Convulsions, Cramps, Lameness, &c. Accordingly as the Humours influenenced by them, are differently acted on, and disposed to shew their ill Effects in this or that Part.

So that it would be of considerable Import to Natural Philosophy, and of no small use in Husbandry, Gardening, as well as Physick, to make such Observations, as might tend to the Improvment of the Theory of the Planets by keeping exact Diaries in several Places, of the Changes of the Weather, and at the same time of the Mutual Aspects, places and Motions of the Planets; Besides, it would not a little conduce to the Perfecting of the Natural Histories of Countries, and particular Places.

But in instituting and perfecting Observations of this kind, we are not yet Furnished with Thermometers, sufficiently improved; for,

First, We are not yet acquainted, what Proportion the Diameter of the Cylinder ought to bear to the Diameter of the Head; to make our Observations of the Alterations in the Air, regular. *Secondly*, We are not told what Length the Cylinder ought to be; nor hath it as yet been well graduated, 16 being the greatest Number; whereas to make Observations on the more Minute alterations, every Inch may be divided into 10, and consequently the whole into a 1000 Degrees. *Thirdly*, We are not yet told what Liquors are most proper to make such Experiments with; Whether such as Attract the Air, and preserve their first Quantities; such as *Ol. Sulph. per Campanam Ol. Vitriol.* or

Liquors, such as *Sal Tartar*, &c. or whether Liquors whose Parts are more subtle and fine, such as Spirit of Wine, or Turpentine; or *Lastly*, Spirit of Vinegar, or well refined Quicksilver.

In making such Experiments, it may be convenient to fix several Glasses in one Frame, with several sorts of Liquors in them; and that Observations should be made in several Rooms together, the Glasses being neither exposed to the Sun Beams, nor to the injury of Storms, Rain or Winds. In the History it self it will be requisite to give an Account of the very place such Experiments were made in, taking Notice whether the Experiments are not influenced by the Air in the Chimney, the Cranny of a Wall or Door, or the Breath of People. It will be requisite likewise to note the Proportion betwixt the Warmth of Day and Night, in constant Weather: The agreement or disagreement of the Motion of the Air, and Bodies above it in uncertain Weather: How far these may foretell Winds or Rain; the disposition of Air, when it Thunders, under times of Mildews or Blasting, eminent Eclipses, Conjunctions.

It is a Received Tradition in *Java*, that the Beams of the Moon, if one stays long under them, will cause Contractures; so that a Physitian, who Slept under them, had his Mouth strangely contorted, and his Neck stiff, which Symptoms he removed sooner than they are wont to go off, by the use of Aromatick Medicines.

TITLE

TITLE XIV.

Of the Height of the Atmosphere.

TITLE XV.

Of the Motion of Air, *and of* Winds.

AT *Porta Nova* Nov. 22. 1667. There was so violent a Rain and Wind, that most of the Houses were Ruined; Men and Beast carried into the Water by the Violence of the Winds and Flood; the Town Wall was most of it thrown down and few Trees left standing. I am told that Hurricanes are very frequent about the Island *Mauritius*, where one lasted four days, in one of which it had seven Exacerbations, each of which differed two Points of the Compass from the Preceding; The surface of the Sea by the Collision of the Waves, was covered with a White Froath; the Day was darken'd by it, and the Noise like that of Thunder, so that those on the Shrouds could not hear those on the Decks. *Storms of Wind.*

A Learned Physitian, that Travelled into *America*, told me, that those Countries are supplyed with a constant Wind from the Hills; but *Barbadoes*, which wants Hills, hath no such Winds. In the Island of *Teneriff* Breezes constantly flow from the Sea; but all Night, a sharp Wind blows on each side from the Land Sea-ward. I am told by a Traveller, that tho' the Tops of Mountains are generally calm; yet he had met with Winds considerably strong.

In Lettere di Venetia

MArtedi ſui li 29. Agoſto 1679. alle hore 19. incirca ſi leuolevò nelle Paludi della Villa di Fauis del Dominio Ceſareo tre miglia lontana da Palma Noua Dominio Veneto un uento chiamato Biſſa boua, che allargandoſi per circa cinquanta paſſi ſcorſe con tanto empito, e furore, che portò per aria diuerſi huomini, che tagliauano il fieno in quei Prati, e anco alcuni Carri carichi di fieno con i Buoui precipitandoli aſſai lontano con la rouina delli animali, de Carri, e degli huomini, e paſſando per i Campi sbarbicando ogni ſorte di Piante le portò per aria gettandole molti paſſi lontano, rendendo la terra per oue ſcorce coſi arſa, che pare non ui ſii mai ſtata piantata coſa alcuna. Arriuò nella villa detta Bagnaria del Dominio Veneto doue gettò a terra molte Caſe ſino a fondamenti, et altre diſcoperſe, e rouinò portando per aria tauole, trani, et ogni altra coſa che era dentro eſſe Caſe reſtando mal trattate molte Perſone senza però la morte di alcuno. Fuori di detta Villa ui e una Chieſa chiamata S. Tomaſo la quale reſto ſcoperta, e rouinata una parte del muro portando uia il Campanile, e Campane che nel giorno ſeguente non erano per anco trouate;—Di là ſi portò uerſo Seniglian Dominio Veneto e rouinò tutta la Campagna ſenza danno però della Villa ſteſſa mentre li paſsò poco lontano, e girando poco lungi dalla Villa ſteſſa ſpiantò da fondamenti un Palazzo del D. Co. Horatio Straſoldo, nel quale gli amazzò ogni ſorte di animali che ui erano, portando per aria li mobili e ſino le botti, eſtermi-

minando parte della poſſeſſione. Non reſtorono però offeſe Perſone, perche erano alla Campagna a lauorare, e nel camino getto pure a terra due altre Caſe che ſono nel Taglio per andare a Straſoldo ſpiantandole affatto con la morte di una Donna, d' un Fanciullo, e diuerſi Animali.

Di là voltò uerſo Palma, et arriuando ſino alle mura della Fortezz agirò uerſo la Villa di Priuano mezo miglio diſtante quale rouinò la meta, ſpiantando da fondamenti beliſſimi Palazzi, portando per aeria travi, tavole, et ogni altra coſa con la morte di molti, quantità di feriti, e diuerſi ſtraſpazzati con far alla Campagna di molto male. Di poi ſcorſe nella Villa di Viſco Dominio Imperiale, e tra li altri danni fatti roninò tutto il Palazzo novo del D. Marco Foſcolini Gentilhuomo di Cinidal nel quale eſſendoni una gran rimeſſa da Carozze, la di cui Porta haueua tre Cadenazzi, & entrando il Turbine per li balconi gettò la Carozza con tanto empito nella Porta ſteſſa che la ruppe, e portò fuori la Caroza tutta fracaſſata gettandola ſopra un muro della Corte aſſa alto, portando il Cielo della ſteſſa mezzo miglio lontano, e vertò nel medemo Palazzo ferito, e mal trattato un ſeruitore di eſſo Foſcolini, di cui ronino pure Braida, & un Brolo eſſendo in detta Villa reſtati due morti, e diverſi feriti ;— S' inoltrò poi nella Villa di S. Vido di Crauglio ſtato Imperiale, la quale rouino tutta affatto ſenza reſtaurui nemeno una Caſa, portando per Aria coppi, travi, legne, ſaſſi, e mobili con la morte di moltiſſime Perſone, e moltiſſimi feriti e rouinati, et in detta Villa non ſi può anddare, ne con Carri, ne con Caualli per la grande moltitudine di rouinazzo, arbori

arbori et altro che hanno attrauer-ſato le ſtrade, eſſendo rimaſſi morti gran numero di animali.——

Da queſto luoco ſi portò uerſo Villes Villa Imperiale buona parte della quale gettò a terra andar al Territorio di Monfalcone con la morte di molte perſone, et quantità di animali con laſciar le Campagne per dove è paſſata ſenza piante, e come ſtrada battuta.——

Hà danneggiato anco altre Ville ma leggiermenre, ne per anco ſi sá quello hauerà fatto piu avanti nel detto Territorio.

Queſto ſucceſſo hà laſciato un ſpauento grande in queſte Parti, eſſendoſi uedute coſe incredibili mentre pioueuano ſaſſi, tauole, arbori, trani, coppi, huomini, donne, fanciulli, botti, ſorghi, uva, galline, animali, et in concluſione ciò che incontraua portaua per aria con un rumore, e fracaſſo coſi gradne, che facena terrore eſſendo per dette Ville un concorſo grande di Popolo uicino per uedere coſe che ſi rendono incredibili.

I am told, that tho' the *Eaſtern* Winds blow near *Tangier* about ½ of a Year, yet they reach not into the Inland Country; where ſuch Winds are not common.

I am told by one who obſerv'd it in the Bottom of a Mine near the Sea, that before *South* Winds the Water would be troubled, but before *Eaſt* Winds it would be clearer than ordinary, the Depth of the Mine was about 15 or 20 Fathom.

He told me likewiſe, that the Hurricanes at *Goa*, come but at two Seaſons; about the beginning of *March*, and the 4th of *October*.

TI-

TITLE XVI.

Of the Air as the Medium of Sounds, and of Sounds and Noiſes in the Air, and Particularly Thunder; and of the Airs Operation on the Sounds of Bodies.

UPon the Riſing of ſeveral Tempeſts together, the Sky ſeems covered over with Globes of Smoaky Clouds, the Air ſeeming black and Thick; and by and by inceſſant Lightning, with terrible loud Thunder breaks out; *Ludolph*'s Hiſtory of *Æthiop.* l. 1. c. 5. *Of the Air as the Medium of Sounds.*

A Viol String hath been Obſerved, upon Rainy weather, to ſound half a Note ſharper than before, and, I am told by the ſame Perſon, that having kept falſe Strings in his Pockets for ſome time after, they became true ones; and the ſame Perſon hath Obſerv'd, that ſome Strings are apter to Receive a Tenſion, than others.

TITLE XVII.

Of the Weight of the Air

HAving placed a hollow Cube of Braſs, every ſide of which was an exact Engliſh Inch, in a pair of Scales as Horizontally as we could, It's Weight being 3xi. gr. 1. ſs. we fill'd it *The Weight of a cubical Inch of Water.*

it with common Water, and then, beſides the Counter-poiſe of the Braſs Cube, the Water weighed 254$\frac{1}{16}$ Grains; and ſince it is a hard Matter to fill the Veſſel more exactly than we did, I judge that a Cubick Inch may way, 256 Grains.

Of Quick-ſilver. A Cubick Inch of Mercury weighed in the ſame Braſs Cube was 3580 Grains, which is to the Weight of Water, as 14 to 1

Of a Pillar of the Atmoſphere. The Weight of the Air incumbent on an Inch Square of Air here below, amounts to 18 l. $\frac{1}{3}$ Troy-weight, *i. e.* 15 l. $\frac{1}{11}$ Averdupois-weight.

As 11 to 14. or rather as 355. to 452, ſo is the Area of a Square inſcribed in a Circle to the Area of the Circumſcribed Circle.

Hence 355 : 452 :: 1 : 1,2732394.

Hence if the ſide of a Circumſcribed Square be an Inch, that Multiplied by an Inch, renders a Cubick Inch for the Solid Content.

In the like manner, if the Height of a Cylinder Erected on the Circumſcribing Circle, be an Inch, the Solid content of that Cylinder is, 1, 2732394.

Wherefore 1, and 1, 2732394, Multiplyed, by the Weight of the Cubick Inch of any kind of Metal, give the Weight of a Cubick Inch, and of a Cylindrick Inch that Circumſcribes the ſame; whence an Inch Table for both is eaſily made, by contiunal addition, or for any Height propounded, Multiplying both by the ſame.

LE Tuyan recourbé eſtoit fermé au bout æ et Ouuert alautre extremité B. La. recourbure depuis G. juſq' a C. eſtoit pleine de Mercure & tout le reſte eſtoit plein d' air. La longueur Æ.C. eſtoit 4 Pouces ou ¾. J'echauffay cet air, et il feit baiſſer le Mercure Juſques en f. qui eſtoit ¼ plus bas, & en meſme temps il monta juſq' en H. qui eſtoit ¼ plus haut que G. ou C. *See Plate 6 Fig. 4.*

Pour ſçauoir quélle hatetur de Mercure auroit eſte neceſſaire pour empeſcher la dilatation de lair, & retenir le mercure en C. je nay qúa trouuer ce qui ſeroit neceſſaire pour repouſſer le mercure en C. Etainſy contenir lair dans léſpace Æ. C. non obſtant la Chaleur. Jepoſe pour principe ceque lexperience fait voir, Ceſt que quand une quantitè dáir occupe un certain eſpace que jáppelle Æ. et que la preſſion qui leretient dans cet eſpace ſoit B. ſi on vient a augmenter cette preſſion de telle quantité que lón voudra comme X. on diminuera l'eſpace Æ. d'une certain quantité D. Laquelle quantité eſt au reſtant M. comme X eſt a B.

D. M :: X. B.

donc.

M. D :: B. X.

Il eſt aiſé d ápliquer cette reigle à lexperience cy deſſus. Car Æ. f. ou ¾ de pouce ſont leſpace Æ. Lapreſſion ordinaire de láir qui eſt de 30 Pouces.

Jointe

Jointe næ un pouce de haut que ſe trouue entre ſ et H. eſt B X 31 Pouces de Mercure: et ſi nous y en adjouſtons aſſez pour reduire láir a léſpace Æ. C. Le dit Æ. C. ſera M. X $\frac{1}{3}$ Et. ſ. C. ſera D. X$\frac{1}{3}$

Poſant donc. M. D. . B.

$\frac{1}{3}$ 32. 3. 31.

La quatrieſme propotionelle ſera X. X $2\frac{2}{3}$ pouces, qui eſtants joints a B. X 31 Pouces feront 33 $\frac{2}{3}$ pouces dont láir ſera preſſé en C. Æ. qui ſont pres de 4 Pouces au deſſus de la preſſion ordinaire.

An Experiment made at the Spire of the Cathedral Church in Sarum.

HAving procured all the Surveying Chains we could, and a proper Frame for a Baroſcope, we went into the Church, where when the Tube was inverted, as in the *Torcellian* Experiment; the Mercury ſtood at 30 Inches, and 50 Centeſms of an Inch: Being drawn up to the firſt floor which is 1033$\frac{1}{2}$ Inches, it ſubſided 9 Cents of an Inch; being drawn up 935 Inches higher, it ſunk 8 Cents more; being drawn up 2313 Inches higher yet, it loſt 23 Cents, and when it was let down again the Mercury reaſcended to it's former Station at every one of the Marks.

At another time an inverted Baroſcop being made uſe of, ſuch as Plate 5, *Fig.* 6, delineates, having ſet a Mark where the Mercury ſtood below, when it was raiſed.

Inches

Inches		*Inch.*	*Cent.*
1033	The Liquor Ascended	1	25
1068		2	39
2467		3	22
4281		5	64
4800 or 400 feet		6	140

On the great Continent not far from the Sea, before a great Storm, in which the Wind blew along the Continent, the Mercury was Raised two Inches above it's usual Station; but when the Wind blew from the Sea, the Mercury subsided; which hath been observed by another Gentleman in *England*, where in the Inland Parts likewise the Mercury subsided before a Storm.

An Extract of a Letter writ to the Author, by the Ingenious Author of that most incomparable Essay of Human Understanding Mr. Lock, *Dated* Ch. Ch. *May* 5th 1666.

An Account of Mine deep Gruffs.

IN the Letter we are inform'd, that designing, at the Request of Mr. *Boyle*, to try some Barometrical Experiments in the Gruffs at *Mendip*, when he came there, he found it neither safe nor easy, for one not accustomed, to go down into them; for the Descent not being Perpendicular, but crooked, as the Crannies of the Rocks gave them way easiest in sinking their Pits, they are forc'd to clamber up and down

down the Narrow Passage, by setting their Hands and Feet against the sides of it, all the Assistance besides, being a Rope which they take under their Arm; besides, sometimes when they are down, the Damps catch them; and if they cannot get out speedily, they fall into a Swond and die: The only Remedy which Recovers them is this, they first Dig a hole in the Earth for their Faces, and then cover them close with Turffs. To force Air into these Gruffs, they place Turfs on the Lee side of the Pits Mouth, instead of which, if they be put on the other side, those in the Gruffs are seised with a want of Breath and Fainting. Sweet Flowers being taken down into them, presently Stink. And it is likewise observ'd, in these Gruffs, that it is very dangerous to descend into them, when any Fire remains in the Chinks of the Rocks; for they usually make such Fires upon hard Rocks, that they may more easily Dig through them.

The *Torricellian* Experiment being tryed, on a Steep Hill, the Mercury at the Bottom was suspended at 29 Inches and ½; at the Top of the Hill it subsided to 28½, where both as I ascended and descended, the Mercury gradually subsided and rose again; only the Sun had so far Rarified the Air above the Mercury, that when the Tube was brought to the bottom again, the Mercury wanted ½ of it's former height, which I suppose depended on the Resistance that Rarified Air made to the Pressure of the *Atmosphere*.

Having visited the Incrusting Spring, I formerly mentioned, I observ'd, that about the Spring-head there was only a little Moss In-

crusta-

cruſtated; but 40 or 50 Yards of it, where the Water hath a Fall higher than my Head, it Sheathed every thing with Stony-caſes, and makes the ſides of the Banks hard Rock. It bears Soap, Freezes Quickly, and Waters Ground with advantage; It is uſed in the Kitchen and Brew-houſe belonging to the Gentleman, in whoſe Ground it Riſes in, without any ſenſible ill Effects; only his Horſes are Obſerv'd to be uſual-ſhort Breathed. Thus for the Extract of Mr. *Lee*'s Letter.

Some days ago the King doing me the Honour to Diſcourſe with me about the uſe of Baroſcopes, he told me, that he himſelf had by obſerving the Baroſcope, foretlod a Storm, which accordingly enſued.

Nous apprenons de ces experiences, que puiſque le poids de l' Air et le poids de l'eau qui eſt dans les Pompes ſe tiennent mutuellement en Equilibre, ils peſent preciſement autant l' un que l' autre; & qu' ainſi en connoiſſant la hauteur ou l'eau s' élve en tous les lieux du monde, nous connoiſſons en meſme temps combien chacun de ces liex eſt preſſé par le poids de l' Air qui eſt au deſſus d' eux; et partant.

Que les lieux qui ſont au bord de la mer, ſont preſſez par le poids de l' Air, qui eſt au deſſus d'eux juſques au haut de ſa Sphere, autant preciſement, que ſi au lieu de cét Air on ſubſtituoit une colomne d'eau de la hauteur de 31 Pieds deux poulces.

Ceux qui ſont plus élevez de dix toiſes, autant que s' ils portoient de l' eau de la hauteur de 31 Pieds un poulce.

Ceux qui ſont élevez au deſſus de la mer de 500 Toiſes, autant que s' ils portoient de l' eau à la hauteur de 26 Pieds onze poulces : & ainſi du reſte.

Nous apprenons par ces experiences que l' Air qui eſt ſur le niveau de la mer peſe autant que l' eau, à la hauteur de 31 Pieds deux poulces ; mais parce que l' Air peſe moins ſur les lieux plus élevez que ſur le niveau de la mer ; et qu' ainſi il ne peſe pas ſur tous les Points de la terre egalement, & meſme qu' il peſe differemment par tout, on ne peut pas prendre un pied fixe, qui marque combien tous les lieux du monde ſont Chargez par l' Air, le fort portant le foible ; mais on peut en prendre un par conjecture bien approchant du juſte ; comme par exemple, on peut faire eſtat, que tous le lieux de la terre en general conſiderez comme s' ils eſtoient également chargez d' Air, le fort portant le foible, en ſont autant preſſez, que s' ils partoient de l' eau à la hauteur de 31 Pieds ; et il eſt certain qu' il n'y a pas un demy pied d' eau d' erreur en cette Suppoſition.

Or nous avons veu que l' Air qui eſt au deſſus des montagnes hautes de 500. toiſes ſur le niveau de la mer, peſe auntant que l' eau à la hauteur de 26 Pieds 11 Poulces.

Et par conſequent tout l' Air qui s' étend depuis le niveau de la mer juſqu' au haut des montagnes, hautes de 500 Toiſes, peſe autant que l' eau à la hauteur de 4 Pieds un poulce, qui eſtant à peu prés la ſeptiéme partie de la hauteur entiere ; il eſt viſible que l' Air compris depuis la mer juſques

ques à ces montagnes eſt à peu pres la ſeptiéme partie de la maſſe entiere de l' Air.

Nous apprenons de ces meſmes Experiences, que les vapeurs qui ſont épaiſſes dans l' Air, lors qu' il en eſt le plus Chargé, peſent autant que l' eau à la hauteur d' un pied huit Poulces; puiſque pour les contrepeſer, elles font houſſer l' eau dans les Pompes à cette hauteur, par deſſus celle ou l' eau contrepeſoit déja la peſanteur de l' Air: de ſorte que ſi toutes les vapeurs qui ſont ſur une contrée eſtoient reduites en eau, comme il arrive quand elles ſe changent en pluye, elles ne pourroient produire que cette hauteur d' un pied huit poulces d' eau ſur cette contrée. Et s' il arrive par fois des orages ou l' eau de la pluye qui tombe vienne à une plus grande hauteur; c' eſt parce que le vent y porte les vapeurs de contrées voiſines.

Nous voyons auſſi de là, que ſi toute la Sphere de l' Air eſtoit preſſée & comprimée contre la terre par une Force qui la pouſſant par le haut, la reduiſiſt en bas à la moindre place qu' elle puiſſe occuper, & qu' elle la reduiſiſt comme en l' eau, elle auroit alors la hauteur de 31 Pieds ſeulement.

Et par conſequent qu' il faut conſiderer toute la maſſe de l' Air en l' eſtat libre ou elle eſt, de la meſme ſorte que ſi elle euſt eſte autrefois comme une maſſe d' eau de 31 pieds de haut á l' entour de toute la terre, qui euſt eſté rarefiée et dilatée extremement, et convertie en cet eſtat ou nous l' appellons Air, auquel elle occupe à la verite plus de place, mais auquel elle conſerve

preciſement le meſme poids que l' eau à 31 pieds de haut.

Et comme il n' y auroit rien de plus aiſé que de ſuppter combien l' eau qui environneroit toute la terre à 31 Pieds de haut peſeroit de livres; et qu' un enfant qui ſcait l' Addition et la Souſtraction le pourroit faire; on trouveroit par le meſme moyen combien tout l' Air de la Nature peſe de liures, puiſque c' eſt la meſme choſe; et ſi on en fait l' épreuve, on trouvera qu' il peſe à peu prés huit Millions de Millions de Millions de Liures.

I' ay voulu avoir ce plaiſir, et j' en ay fait le compte en cette ſorte.

I' ay ſuppoſé que le Diametre d' un cercle eſt à ſa circonference, comme 7 à 22.

I' ay ſuppoſe que le Diametre d' une Sphere eſtant multiplié par la circonference de ſon grand cercle, le produit eſt le contenu de la ſuperficie Spherique.

Nous Scavons qu' on a diviſe le tour de la terre en 360 degrez. cette diviſion à eſté voluntaire, car on l' euſt diviſée en plus ou moins ſi on euſt voulu, auſſi bien que les cercles celeſtes.

On a trouve que chacun de ces degrez contient 50000 toiſes.

Les lieues autour de Paris ſont de 2500 toiſes; et par conſequent il y a 20 lieues au degré: D'autres en comptent 25 mais auſſi ils ne mettent que 2000 toiſes à la lieue; ce qui revient à la meſme choſe.

Chaque toiſe a 6 pieds.

Un pied Cube d' eau peſe 72 libres.

Cela poſe, il eſt bien aiſe de faire la ſupputation qu' on cherche.

Car

Car puiſque la terre a pour ſon grand cercle, ou pour ſa circonference ..... 360 degrez.

Elle a par conſequent de tour ..... 7200 lieuves.

Et par la proportion de la Circonference au Diametre aura ..... 3291 lieues.

Donc en multipliant le Diametre de la terre par la Circonference de ſon grand cercle; on trouvera qu' elle á en toute ſa ſuperficie Spherique..... 1649200 lieues quarrées.

C' eſt à dire ..... 103,095, 000, 000, 000, toiſes quarr.

C eſt à dire ..... 3711, 420, 000, 000, 000, pieds quarr.

Il's enſuit qu' un pied cube d' eau peſe 72 livres.

Et parce qu' un priſme d' eau d' un pied quarre de baſe, et de 31 pieds de haut, peſe 2232 livres.

Donc ſi la terre eſtoit couverte d' eau juſques à la hauteur de 31 pieds; il y auroit autant de priſmes d' eau de 31 Pieds de haut, qu' elle a de Pieds quarrez en toute ſa ſurface. (Ie ſcay bien que ce ne ſeroient pas des priſmes, mais des ſecteurs de Sphere; et je neglige exprés cette Preciſion.)

Et partant elle porteroit autant de 2232 livres d' eau, qu' elle a de pieds quarrez en toute ſa ſurface.

Done cette maſſe d' eau entiere peſeroit.

8283, 889, 440, 000, 000, 000, livres.

Donc toute la maſſe entire de la Sphere de l' Air qui eſt au monde, peſe ce meſme poids de 8283. 889, 440, 000, 000, livres.

preciſement le meſme poids que l' eau à 31 pieds de haut.

Et comme il n' y auroit rien de plus aiſé que de ſuppter combien l' eau qui environneroit toute la terre à 31 Pieds de haut peſeroit de livres; et qu' un enfant qui ſcait l' Addition et la Souſtraction le pourroit faire; on trouveroit par le meſme moyen combien tout l' Air de la Nature peſe de liures, puiſque c' eſt la meſme choſe; et ſi on en fait l' épreuve, on trouvera qu' il peſe à peu prés huit Millions de Millions de Millions de Liures.

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Nous Scavons qu' on a diviſe le tour de la terre en 360 degrez. cette diviſion à eſté voluntaire, car on l' euſt diviſée en plus ou moins ſi on euſt voulu, auſſi bien que les cercles celeſtes.

On a trouve que chacun de ces degrez contient 50000 toiſes.

Les lieues autour de Paris ſont de 2500 toiſes; et par conſequent il y a 20 lieues au degré: D'autres en comptent 25 mais auſſi ils ne mettent que 2000 toiſes à la lieue; ce qui revient à la meſme choſe.

Chaque toiſe a 6 pieds.

Un pied Cube d' eau peſe 72 libres.

Cela poſe, il eſt bien aiſe de faire la ſupputation qu' on cherche.

Car

Car puiſque la terre a pour ſon grand cercle, ou pour ſa circonference ..... 360 degrez.

Elle a par conſequent de tour ..... 7200 lieuves.

Et par la proportion de la Circonference au Diametre aura ..... 3291 lieues.

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Donc toute la maſſe entire de la Sphere de l' Air qui eſt au monde, peſe ce meſme poids de 8283. 889, 440, 000, 000, livres.

C' eſt à dire, Huit Millions de Millions de Millions, deux cent quarte vingt trois Mille huit cent quatre vingt neuf Millions de Millions, quatre cent quarente Mille Millions de livres.

Mr. *Paſcal* in his ſmall Tract, either *De la Peſanteur de l' Air*; or in that *De l' Equilibre des liqueurs.*

See Plate 7 Fig. 4. De cætero, feci haud ita pridem experimentum ponderandi aeris, quod pulchré ſucceſſit; nam ſumptâ vitreâ lagenâ, valde levi et ad lampadem ſuffiatâ, ejus figuræ, qualem alibi excuſam vides, magnitudine parvæ pilæ quales habentur in ſphæriſteriis, non habente niſi minimam quandam aperturam per quam immittatur pilus in extremitate orificii ſui B. ponderavi eam in lance valde exacta, & frigida pondus habuit 78 granorum cum dimidio: Poſtea calefeci eam carbonibus impoſitam, & repoſui in bilancem eo ſitu quo hic deſcriptum vides, nimirum orificio in imum verſo, & deprehendi eam vix habere pondus 78 granorum, tum immergendo orificium in aquam, refrigeſcere feci, & dum aer ſe condenſat pro modo quo refrigeſcit lagena, intravit tantundem aquæ quantum aeris calor antea expulerat; denique ponderans eam cum omni illa aqua deprehendi eam habere pondus 72 granorum & dimidii plus quam antea: unde concludo aerem qui per ignem expulſus erat, ſe habere ad aquam quæ in locum ſuum regreſſa erat uti $\frac{1}{2}$ ſe habet ad $72\frac{1}{2}$, aut uti ſe habet 1. ad 145. ſed potui in eo erraſſe difficile, quippè eſt in ea re omnino exactum eſſe; Id ſaltem certò ſcio, quòd pondus

dus aeris hoc modo ſit ſenſibile, & prolixe hic deduxi proceſſum meum, ut ſi te eadem curioſitas inceſſat, poſſis id eodem modo perficere experimentum. Vale.

TITLE XVIII.

Of the Conſiſtency of the Air; *it's Rarity, Denſity, Fluidity, Subtily.*

A Thin, but large Bladder, having a third Part of the Air, it was capable of containing, remaining in it, had it's Neck ſtrongly tyed; and at the other end a Weight was ſuſpended of 14 Pound by a String, which could not ſhrink ⅛ of an Inch, without raiſing the Weight from the ground: But the Air in the Bladder was ſo far expanded by heat, that the Weight was raiſed, and would ſwing in the Air like a Pendulum. The ſame Experiment being tryed with a 50 pound Weight, before the expanded Air was able to raiſe the Weight, the Bladder would burſt. *Of the Conſiſtency of the Air, &c.*

To try whether the Corpuſcles of the Air would penetrate into a Liquor expoſed to the Ordinary preſſure of the *Atmoſphere*, we poured a Urinous Spirit upon as much Filings of Copper, as covered the bottom of a Cylindrical Vial, ſo that the Spirit was the Breadth of 3 Fingers above the Filings, which being done, on that, we poured ſo much Oyl of Almonds, as covered the Spirit the Thickneſs of a Crown piece; upon which the Vial being kept ſome days in a quiet place, the Urinous Liquor did

first acquire, and then loſe a blew Tincture. When the blew was in a great Meaſure vaniſhed, the Bottle was kept unſtopped a Minute, and then ſtopped again; in a ſhort time the Urinous Spirit was tinged with blew, which Colour in an hour extended it ſelf all over the Liquor, the Oyl upon the Top of it ſtill remaining clear.

TITLE XIX.

Of the Heat and Coldneſs of the Air.

TO ſhew that it is not without Reaſon that I Queſtion what the Peripateticks teach about the Limits and Temperaments of the Air, which they divide into three Regions, I ſhall propoſe the following Particulars.

The Air at *Morocco*, tho' exceſſive hot in the Day is Cold at Night, as well as the Mountanous Parts thereabouts.

One, who ſtayed a Year in *Guinea*, tho' it is exceſſive hot, told me, that about 4 a Clock in the Morning, he was ready to tremble with Cold.

One told me, that in *Jamaica*, when he lay in his Hammock about 3 or 4 Foot from the Ground, tho' he had much Cloths under him, yet he perceived it Cold beneath, and Hot above.

So that to ſhew that not only Liquors, and Animal Bodies may be affected with the Summers heat, but even Glaſs it ſelf, I ſhall intimate, that Glaſs-ſtopples of Factitious Cryſtal being ſo fitted to Viols of the ſame, tho' in Winter they would move about

about eaſily; yet in the Summer they would not be pull'd out by the Aſſiſtance of a String, till the Expanſion of the Glaſs was taken off by being cool'd in Water.

I am apt to believe, that ſeveral Effects, which we are apt to attribute to the Heat of the Air, putting the Parts of the Juices of our Bodies in Motion, depend on ſome *Effluvia* rais'd by Heat from other Bodies, and which ſwim in the Air.

A large Piece of Amber being plac'd in the Summer in the Sun-Beams, had its Parts put into ſuch an Agitation, as enabled it to emit Electrical *Effluvia*, and to attract light Bodies, which Power it would loſe when remov'd out of the Sun-Beams again.

Mr. *Nickſon* told me, that, near *Hudſon's Bay*, when they were a *Leeward* of certain floating Iſlands of Ice, they were ſenſible of it by a new Acceſs of Cold; before they approach'd ſo near as to ſee them, which was at 20 Miles diſtance. He likewiſe told me, that that Wind brought along with it a Foggy Air; And that in that of *Hudſon's Bay* where he winter'd, the Rivers were not free from Ice from the latter End of *October*, to the middle or end of *May*, tho' the Latitude of *Charlton* Iſland, moſt frequented by the *Engliſh* was of the ſame Latitude with *London*, and at the moſt not exceeding 52 Degrees: The Ice was near ſix Foot deep; and the Froſt ſo violent, that Bottles of Brandy would have a fourth Part turn'd into Ice, the unfroze Liquor being much ſtronger than before: The Ice which ſwam upon the Water was freſh, from whence they ſupply'd themſelves with freſh Water, either

ther by melting it in their Pots, or by gathering it from large Cavities in floating pieces of Ice, where it was melted by the Sun-Beams.

A Traveller told me, that upon the Top of a *Pyrenean* Mountain in the Summer it was very hot, tho' the same Day it was cover'd with Snow; and another told me, that the Winds at *Morocco* were so hot, as almost to stifle him.

And it hath been observ'd, upon the Tops of high *Pyrenean* Mountains, that, below them there were Clouds which yielded Rain plentifully, out of which Lightning flash'd upwards as well as downwards.

Dr. *Stubbs* told me, that in a Bolt-head about 2 Foot ½ long, about 7 or 8 a Clock in the Morning, which is the faint time of the Day, the Water would rise but ¼ of Inch and half a quarter, after which time it would subside till that time the next Day. He further added, that in 8 or 10 Months time in that hot Country, Water would not decrease in Quantity, tho' kept unstopp'd.

I am told by another, that in the *Torrid Zone* near the Coast of *Sumatra*, tho' Ice nor Frost nor Snow are ever observ'd, yet he hath known Hail to fall. And I am told, that in the Island of *Ceylon*, which lies betwixt 6 and 10 Degrees *North* Latitude in that Torrid Climate, it would be so cold at the Top of some Hills, to whose Tops they could ascend in half an hour, that they would almost shiver. And Capt. *Knox* told me, that having spent 18 Years in that Island, he observ'd a kind of Meteor in Winters Mornings between a Dew and a hoar Frost, which pre-

preſently vaniſh'd; and that once there happen'd a ſhower of Hail, which were about the ſize of a black Cherry, but were preſently melted upon the Ground.

The Heat is ſo violent in the Iſland *Suaquena*, that it excoriates the Skin, melts *Indian* Wax in a Cabinet, and ſears your Shoes like a red hot Iron. Yet on ſome Mountains in *Æthiopia*, they dread Cold more than Heat; tho' no Snow falls, but only a little Hail now and then, which ſoon melts; and *Telleſius* witneſſes, that in many Regions in *Æthiopia*, the Air is more mild than in *Portugal*, ſo many Degrees diſtant *Northward*.

At *Tripoli* in *Barbary* it is obſerv'd, that when the Wind blows over a long Sandy Deſart, it, as well as the Wind it brings along with it, ſeems as hot as the Steams from an Oven: And and the ſame hath been obſerv'd near the Iſland of St. *Lovis*, on the Coaſt of *Africk*; where it was further remarkable, that the Ground was ſo hot, that the Gentleman, who related it, could ſcarce endure to ſtand upon it; and he further told me, that when the Wind blew from a Wood, in which the dead Bodies of Wild Beaſts lay, it ſtunk ſo that it could ſcarce be endured.

In ſummo ejus montis, Idæ ſc. faſtigio ſacellum eſt, quod ædificiolo duntaxat conſtat ſaxis ſibi invicem impoſitis & ſine calce cohærentibus fornicis in modum conſtructo, ad tectum prębendum. Sublimi adeo loco eſt, & à vehementioribus ventis interdum ita perflato, ut lapilli inde transferantur. Paulo infra id ſacellum planities conſpicitur montibus undique Petri Bellonii, lib. 1. cap. 16.

undique cincta, in quâ multa sunt pascua, ubi Arietes & Capræ Cretenses æstate pinguescunt. Si quis ex summo montis vertice undique prospiciat, parum aberit, quin totius Insulæ ambitum videat cum aliis vicinis Insulis, Miso, Cerigo, sive Cythera, reliquisq; Archipelagi. Aeris intemperies in hoc monte adeo magna est quemadmodum ut in cæteris præcelsis montibus, ut in ipsis Canicula ardoribus meridie, nullo etiam spirante vento, ingens sentiatur frigus: qua de causa nec hyeme, nec æstate quisquam eum incolit. Nam licet pastores interdiu ovium greges ad pascua agunt, noctu tamen in valles se recipiunt.

In the next Chapter.

Latè porro patet hic mons ejusque radices utrinque maris littora, ut ante diximus, attingunt; nam licet urbi Candiæ sunt vicina, meditullium tamen insulæ occupat ipse mons, adeo in sublime evectus, ut nives ejus verticem perpetuò tegnant; tamque frigida aura mediis etiam æstatis ardoribus isthic est, ut vix ferri queat: tametsi in convallibus magnus sit æstus.

Jacobi Zabarelli de Regionibus Aeris, c. 8.

Contigit id meæ experientiæ, quod etiam aliis contigisse audivi, ut ascenderem ad summitatem usque montis Veneris, qui omnium in Patavino agro altissimus est; ibi per totum diem habui Aerem serenissimum, sed infra circiter medium montis vidi nubes, quæ me visione vallium prohibebant, vesperi autem postquam de illo monte descendi, inveni factam eo die infera parte magnam pluviam cum in montis cacumine nihil pluisset; ex eo intellexi me transisse per mediam Aeris regionem, in

in qua eſt facta pluvia, nec tamen eam ſenſi frigidiſſimam, imò vix aliquam animadverti differentiam frigidioris & calidioris Aeris, nam æſtivum tempus erat, pro æſtivo tempore eram veſtitus, nec tamen tantum frigoris, quod me læderet, ex eo loco percepi; pars igitur illa non eſt abſolutè frigida, ſed ſolùm comparatione inferi, Aeris calidioris.

Idem de Alpibus *proprio exemplo edoctus teſtatum reliquit* Bartholinus *Syſt. Phyſ. Inſtit. Succinct. de Terra, Aere & Igne*, C. 4. Reſp. 1.

Mount *Atlas* in the Heat of Summer hath been ſeen cover'd with Snow; and ſeveral People who have viſited the Tops of high Mountains, ſuch as the *Alpes* and *Teneriff*, have found it exceedingly cold. I am told by one, that he never heard of Snow or Ice in *Guinea*; but in *Barbary*, where the Plains were exceſſive hot, the Tops of Mountains were cover'd with Snow, and the like hath been obſerv'd in the Iſland *Ceylon*, and the Mountains of *Congo*.

In the Summer 88, I plac'd a Glaſs in a Cave, which faced the Sea, it being cover'd with 80 Foot of Earth, and cut right in about 130 Foot, the Mercury ſtood ½ above Temperate; and at the ſame time, in another Glaſs in the open Air it ſtood at hot: About *Chriſtmas* following the Mercury in the Cave vary'd not, but that without ſtood at Froſt.

In *New-Hampſhire* in *New-England* it is obſerv'd, that in the Winter the *North-Weſt* Wind is very cold, and in Summer intenſly hot; It is aſcrib'd to a large Tract of Woody Land, which in the Winter is cover'd with Snow, and

in

in the Summer, the Valleys being close, keep in the Heat till it becomes very violent.

Balbini Hist. Bohem. l. 1. c. 9. De montibus, & de valle Lauczka, p. 29. Chanowsky in vestigio Bohpiæ, C. ult. Montes parte altera æstatem, altera hiemem referentes.

De montibus ad Bavariam stantibus mira est Alberti Chanowii *nostri narratio: Post Bergreichenſteinam (oppidum fodinis hodieque nobile) esse montes non tam situ (alii enim ad septentrionem, alii ad meridiem latus obvertunt) quam Cœlo & temporibus adversantes, vallibus latissimis montes illos dirimentibus; monstri instar est (quod se vidisse, &* Anno 1639. *in rem præsentem venisse religiosissimus ille & Apostolicus vir asserit) in altero monte sæpius æstatem, in altero apposito hiemem dominari, ita ille succus æstivat, hic altissimis nivibus obsitus à viatore superari non potest; ob eamque causam Messes ipsa variant, & dum in montibus ad nos obversis demessa sunt omnia, altera Montium parte seges virescit: Mirum illud quod in Biessinentibus & Czachrovienſibus Agris in tractu Plsnenſi, contiguis, quos unus tantum sulcus dirimit ac dividit, deprehenditur: Czachrovienses adhuc hibernant, cum in Biessinenſi Cœlum ardeat, ibi caput attollit humo frumentum, cum Czachrovii adolescit in culmum; elemento quoque dispari, illud riget, hoc tepet & fervet, eâque ex causâ, dum Czachrovienses bene pelliti ingrediuntur, Biessinenses pellibus onerari se sentiunt, villosque deponunt. Aliquid tale* Anno 1652. *mihi quoque accidisse memini: nam cum Glacio Zambergam in* Bohemia *contenderem, & Glacio ob nives altissimas certum vehiculi genus, quod trahas dicimus, sumpsissem, superatis montibus, qui comitatum Glacensem à* Bohemia *dividunt, subitò alia rerum facies apparuit: altero enim montium latere viridia omnia reperimus, sic ut Traha nulli*

Id. Ibid.

jam

jam rei & uſui eſſent, & currum petere cogeremur, niſi in luto natare placuiſſet; at accolæ montium illorum quotannis id ſibi accidere confirmabant, ut unum latus montium profundiſſimæ nives contegerent, quando alterum latus lectiſſimos flores proferret, & cum ibi omnia ventis verti viderentur apud ſe è floribus ſuaviſſimos odores efflari.

I was told by a Gentleman, who ſeveral times went down into the *Hungarian* Gold Mine at *Cremnitz*, that when he was drawn up the Groove, which was about 100 Foot deep, as ſoon as he aſcended half the way, he perceiv'd the Air ſenſibly warmer, which continu'd ſeveral Feet nearer the Day; in which Region he obſerv'd, ſeveral Veins of Native Vitriol of different Colours, which were ſoft under Ground, and being expos'd to the open Air, preſently hardened. Under the *Torrid Zone* the Mariners, I am told, hang up their Bottles of Liquor in a Linnen Cloth, that the Wind may blow upon it, by which means it would be cool'd enough to make it fit for drinking.

The Heat of the Sun is ſo violent in ſome Parts of *Moſcovy*, *Norway* and eſpecially at *Mozambique*, that it often ſets the very Houſes on fire; which I the leſs wonder at in the latter place, becauſe they build their Houſes with a Stone that abounds with Sulphur *Viv.* When the Sun is in the *Zenith*, the ſandy Ground is ſo hot, that they can ſcarce endure to tread on it.

Un Gentilhomme de mes amis plein de merit & digne de creance me mande entre pluſieures choſes extraordinaires qu' il a obſervées proche de Barege

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aux Pyrenées, qu'il y a des ponts de niege d'un rocher à l'autre pardessous les quels passent des torrents. Il en a vu un qui embrasse deux torrents, & qui a vint neuf toises de long & autant de large par dessus. Il y a par dessous ce pont Neuf toises & demi entre les Naissances de la voute les ponts sont tellement forts qu'il estime que du Canon y passeroit, & il a fait rouler de grosses pieces par dessus.

Le tremblement de Terre que souffrit la Syrie l'an 750. ne fut gueres moins surprenant; puisque la Terre s'estant ouverte de toutes parts, plusieurs Villes furent abîmées, d'autres renversées, & quelques unes qui estoient elevées sur des hauteurs transportées dans des plaines eloignées de six mille de leur situation. On en peut dire autant du froid extreme qui l'an 753. glaça le Pont-Euxin a la longueur de cent mille, & toute l'estendue de la mer voisine, jusq' à 30 condées de profondeur, quoy qu'on ne fût encore qu'au commencement de l'automne. Journal de Scavans III. 1685.

It is the Custom at *Guinea* to cool their Water by burying it all Night under Ground: And on the contrary in some Places it is so excessive Cold, that in the Woods, it would freeze our Eye-lids; the outside of the Houses would be half cover'd with Snow, and Ice-ickles would hang on the Insides; the Cloaths on our Beds would be cover'd with a hoar Frost, and Water which stood near the fire, would have one side hot, and the other froze: The Sea would be froze up till the beginning of *June*, and the Ground till the beginning of *July*. Capt. *James*.

I was told by one who ascended to the Top of the

the *Pic de Medi*, a *Pyrenean* Mountain, that tho' the *North* side was covere'd with Snow, yet the Heat of the Sun-shine could scarce be endur'd on the *South* side; this Hill is so high, that it may be seen from *Montauban* 27 Leagues distant.

An Ingenious Physician told me, that tho' Julap at *Tangier* might be reduced to Powder; yet at *Morocco* it was so melted by the Heat of the Air, as to become incapable of being powdered.

Nel capo di comorino si termina così l' estâ, come l' inverno dalla parte, di la dal capo verso Notte, & dall' altra parte corrispond illi tempo alla contrario è civerso, di maniera che, chi va navigando, per quella costa nel mese di Ottobre, fino ad Aprile naviga nel estâ, è non puo in tutto questo tempo, passare il capo per Esser ini la stagione del inverno, & il Puerè, che resiede nelle Chiese ch' appartengono al Capo di Comorino ne Alcune la state, il che è cosa di gran Meraviglia, essendo cio nel medessimo tempo nella distanza sola mente di due, o tre miglia.

An eminent *Virtuoso* descended into a Mine in *Tirol* 1800 Foot deep, without taking notice of any hot Region by the way; and at the Bottom the Air was so temperate, that notwithstanding what is said of *Antiperistasis*, no intense Cold was retreated thither to shun the Heat of the superior Air.

One that descended into several Mines in *England*, observ'd it sensibly colder, when he was about a Yard below the *Fast*, as Miners call that solid Earth, which they distinguish from

that looſer Earth that lies above it, in which Plants and Trees ſpread their Roots, they ſeldom reaching to, or penetrating into the *Faſt*, tho' ſometimes it lies near enough the External Surface of the Earth.

An Exact Relation of the Pico Teneriff.

A relation of Mount Teneriff.

The Gentlemen who gave the following Account, ſet out from *Oratava*, a Town ſituated on the *North* ſide, two Miles from the Sea, and in 8 hours got to the Top of the firſt Mountains, towards the *Pico de Terana*, from whence the Company proceeded over ſandy and lofty Mountains, which were not cover'd with Pine Trees as the firſt 8 hours Paſſage was: This Way continu'd till they came to the Foot of the *Pico*, where they found very large Stones, which ſeem'd to have fallen from ſome ſuperior Part.

Thoughts concerning the cauſe of it's ſtupendous Bulk.

It is thought by Dr. *Pugh*, that the whole Soil in that Iſland being ſulphureous, did take fire, and moſt of it Blew up at the ſame time; in which general Conflagration, he ſuppoſes, thoſe many Mountains of calcin'd Stones which lie up and down the Iſland, but eſpecially the *South-Weſt* Parts of it, were caſt up; and the greateſt Quantity of Sulphur lying about the Center of the Iſland, rais'd the *Pico* to that Height, which it now remains at. On the *South-Weſt* ſide theſe calcin'd Rocks lie one upon another from the Top of the *Pico* to the Sea ſhore, but very few on the *North*; ſo that he ſuppoſes the *Vulcano* chiefly diſcharg'd it ſelf that way; ſeveral of theſe calcin'd Rocks reſemble Iron Ore; ſome Silver, and others Copper; eſpecially in the

the *South-West* Parts call'd the *Azuleios*, there are vaſt Quantities of a blewiſh Earth, intermix'd with blew Stones, which are cover'd with a yellow Ruſt, like that of Vitriol or Copper; and he was told, that a Bell-Founder of *Orotava* got pure Gold out of two Horſe Loads of Earth; and he was further told by another, that a Lump of Earth brought from the Top of the Mountain, yielded a good Quantity of Silver. About this Mountain are likewiſe obſerv'd, ſeveral Vitriolate as well as Nitrous and Martial Springs. To confirm this Notion of the Reaſon of what he obſerv'd, he alledges, that the very Tracts of the Torrents of Sulphur which ran down from the Mountain are yet viſible, which did ſo much Damage to the Ground it flow'd upon, that nothing but Fern is able to grow upon it. But what ſeems further to confirm his Account is, The Inſtance of the *Palm* Iſland 15 Leagues from *Teneriff*, where upon the firing of a *Vulcano*, the Earth ſhook terribly, and the Torrents of flaming Sulphur made as loud a Noiſe as Thunder; and the Light of it made the Rooms as light all Night for ſix Weeks, as if Candles had been in them, and the Sand was carry'd about in the Wind like Clouds.

But to proceed: What was further obſerv'd by Mr. *Clapham* and others, who purpoſely aſcended this Mountain: As ſoon as they were got a Mile in their Aſcent upon the *Pico*, ſome of them grew faint and ſick, ſeveral that aſcended were taken with Fluxes and Vomitings, and were Aguiſh; their Horſes, and even their Wine as well as themſelves being extreamly cold. When they had aſcended a Mile further, they

came to the black Rocks, from whence they travell'd over a white Sand, ſo hot that it burnt the Skin of a Dog's Feet who went up with Dr. *Pugh*. When they came to the Top, there were ſulphureous Steams copiouſly aſcending and continually, which were ſo hot, that they made their Faces ſore, and at a little diſtance appear'd like Smoak.

There was little Alteration in the Wind, till we came to the Top, where it was very impetuous. The ſtrong Waters there had loſt their Force, but the Wine ſeem'd rather more Spirituous.

An account of the Pico. Upon the Top is a Pit call'd *Caldera*, of a Conical Figure, which is about 80 Yards deep, and a Muſquet-ſhot over; It is cover'd over with looſe Stones, Sulphur and Sand, which being ſtirr'd, very offenſive Vapours are rais'd; it is dangerous to go further than 4 or 5 Yards into it, becauſe their Feet are apt to ſlip from under them. In the Bottom is a ſort of clearer Sulphur, which looks like Salt upon the Stones.

From hence they could ſee the Grand *Canaries*, *Palma* and *Gomera*, and *Hiero*, 20 Leagues diſtant. When the Sun roſe, the Shadow of the Mountain cover'd all betwixt it and the Horizon, ſo that the Top of it caſt it's ſhade into the Clouds; but when the Sun roſe higher, ſo many Clouds were rais'd, that we could ſee nothing but the Emergent Tops of ſome Mountains, which to thoſe that are below, ſometimes ſeem to be wrapt about the *Pico*, and upon *North-Weſt* Winds foretel a Storm. From the Tops of moſt of thoſe Mountains very exuberant Springs iſſue out in great Spouts. At the Foot of the Sugar-

Sugar-Loaf is a Cave about 10 Yards deep, and 15 broad, having a Hole at the Top 8 Yards over; oppoſite to which, in the Bottom, is a round Pit of Water 6 Fathom deep, whoſe Brink is about a Yard below the Surface of a Bed of Ice which encircles it, the Orifice of which is as broad as the Overture above, ſo that thoſe that deſcend into it, are let down by a Rope, and ſwing to and fro, that they may light upon the Snow. The Water ſeems to be only melted Ice: From the Top of this Cave Ice-icles hang very plentifully.

The Perpendicular Height of the *Pico* is accounted two Miles and a half.

Trees and Plants, &c.

In all the Paſſage nothing but Pines grew; and amongſt the white Sand, a buſhy Broom; and where, in their Aſcent they lay all Night, a ſort of *Cardon*, whoſe Stems are Eight Foot high; the Trunk about half a Foot Thick, every Stem growing in four Squares, and riſing from the Ground like Tufts of Ruſhes; on the Edges of theſe grow ſeveral red Berries, which by ſqueezing, yield a poyſonous Milk, which ſcorches the Hair off where it lights on the Skin of any Beaſt, ſo that I ſuppoſe it to be a kind of *Euphorbium*. In this Iſland there likewiſe grows a Shrub call'd *Legnon-vell*, which is carry'd to *England* as a Sweet-Wood. There are growing in this Iſland alſo, Apricocks, & Peaches, which bear twice a Year; very fruitful Pear-Trees; Almonds of a tender Shell, Palms, Plantanes, Oranges, Limons, and eſpecially *Pregnades*, call'd ſo becauſe each of them carries a ſmall one in it's Belly. Beſides theſe, they have Sugar-Canes, Cotton and *Coloquintida*, Carnations,

tons, and Roſes that blow at *Chriſtmaſs*; Sampler covers the Rocks, and Clover the Ground; and another Graſs grows near the Sea, which is of a broader Leaf, and ſo luſcious, that it will kill a Horſe, tho' no other Cattle: 8 Ears of Wheat have been found to ſpring from one Root, and a Buſhel to yield 130.

Birds. The *Canary* Birds build in the *Barrances* of *Gilt*, which the Water hath fretted away in the Mountains, places very cold. They have alſo Quails and Partridges leſs than ours; great Wood Pigeons, Turtles at Spring, Crows; and ſometimes the Falcon appears from the Coaſt of *Barbary*.

Beaſts, &c. They have Goats on the Mountains, and alſo Hogs and Conies, but their Camels come from *Lancerote*. Amongſt their Fiſh are the following, *viz.*

Fiſh. The *Cherna*, a large well-taſted Fiſh. The *Mero*, Dolphin, Shark, Lobſters, Muſſels, Periwinkles, and the *Clacas*, the beſt Fiſh in the World, which grow in the Rocks, 5 or 6 under a Shell, through the Top of which they peep with their Nebs. They have likewiſe a Fiſh with 7 Tails, each of which is a Span long united to a ſhort Body, and much reſembling our Eel. They have beſides theſe, Turtles, and *Cabrids*, preferable before our Trouts.

Springs. The Iſland is full of Springs of pure Water like Milk, which in *Laguna* they ſtrain through a Baſon made of a Spungy Stone.

Vines. Their Vines are very plentiful.

Cuſtoms of the Inhabitants. Dr. *Pugh*, who had done ſome charitable Cures amongſt the Antient Inhabitants, called *Guanchies*, was permitted to viſit the Caves where the dead Bodies lie, which are ſew'd up in Goats Skins, re-

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ry curiously and close, with Thongs of the same; which are more soft and pliable than our Kid's Skins. The Preserving of Bodies thus by Embalming them, was a Custom of a Particular Tribe of Men, who marri'd only amongst themselves, and kept their Art of Embalming to themselves; so that, upon the Conquest of the *Spaniards*, most of them being destroy'd, the Knowledge they retain of the Ingredients is by Tradition, which is that,

Of the Embalming of Bodies.

They boil in Butter of Goats Milk, which for that Purpose is preserv'd in the Skins. 1*st*. A sort of Wild Lavender. 2*ly*, A Gummy Herb call'd *Gara*, which grows on the Mountains. 3*ly*, A kind of Sow-Bread. 4*ly*, A Wild Sage, of which they make a Balsam, and when their Bodies are Embowel'd, and several times wash'd in a *Lixivium* of the Bark of Pine-Trees, and dry'd again either in the Sun in Summer, or in a Stove in Winter; they then several times successively anoint them with the Balsam, and dry them again, till they grow light, and the musculous parts appear through the shrievel'd Skin, and then they sew them up in Goats Skins curiously dress'd; but the Poorer sort having their Brains taken out, are sew'd up in Skins which have the Hair on. They have above 20 whole Families of their Kings and great Persons, which they will not discover. They are laid in several Postures; and some of them being laid along on Beds of Wood so harden'd, that Iron will not cut them. They also have Earthen Pots so harden'd, which they boil their Meat in; They make their Knives and Lancets of a kind of Slate call'd *Tabona*.

Their Food. Their Food is Barly roasted and ground betwixt two Stones, which they make into Cakes with Milk and Hony, and carry it on their Backs in Goats Skins.

They drink no Wine; nor do they care for Flesh; But are Lean, Tall, very Active and Couragious.

Activity. They will leap from one Rock to another, sometimes Ten Fathom deep. Having a Lance which they point at the Place which they design to light on, and then when they leap, they clap their Feet to the Lance, which Lance lighting on the Rock first, takes off the Violence of their Fall: Novices often break their Necks in learning. They whistle so loud, they may be heard 5 Miles; and it so affected the Relator's Ears, who was in Company with one of them, that he could not hear well of 15 Days after. Besides, they throw Stones with as much Force as a Bullet goes out of a Gun.

But to return to Mount *Teneriff*, by one that went to the Top; it was observ'd, that no Snow was on the *South* side, and tho' it was on the *North* side, yet it was not within two Miles of the lowest part of the *Sugar-Loaf*.

He likewise observ'd, that tho' the Sack which they drank at the Top was exceeding cold, and seem'd to have no Effect on them; yet when they came into a thicker Air, two of the Company were drunk.

Having try'd to fire a Birding-Piece upon the Top of the Mountain, he could not; the Company that gave the former Relation, say they did. The sulphureous Matter they travell'd over was so hot, that it burnt two or three pair of

of Pumps in pieces in the Journey, tho' their Feet were not ſenſibly more hot than at other times. In ſome Regions of the ſame Mountains it was very hot, and on the other ſide of the ſame, very cold. *Query.*

To what Depth the Water will be frozen in hard Winters.

To what Depth the Earth will be froze at the ſame time.

Whether *Muſcovian* Ice be harder than that in *England.*

Whether Liquor caſt up, will freeze before it comes to the Ground.

Whether Brandy, Sack, *&c.* will freeze in *Ruſſia.*

Whether Inſtruments of Iron or Steel be britler there than here.

Of the cracking of Timber and the Cauſes of it in Wooden Houſes.

Of the Preſervation of Fleſh, Fiſh, Herbs, *&c.* in hard Weather.

Of the curing of thoſe whoſe Noſe or Cheeks, *&c.* are frozen.

Of the Symptoms of thoſe that are froze to death.

Of the keeping of dead Bodies.

TITTLE XX.

Of the Air *in Reference to Light, it's Perſpicuity, Opacity, Reflections, Refractions, Colours, Light and Lightnings.*

Of the Air in reference to Light &c.

I Am told by a Traveller, that on the Coaſt of *Genoua*, from a high Place he could ſee Places remote, in a Morning, tho' not when the Sun was near the Meridian.

The late King *Charles* the Second told me, that walking upon the Beach on the *Strand* by *Dover*, he unexpectedly diſcern'd a Coaſt, which had riſing and falling Ground, upon the Virge of the Horizon; and the ſame was obſerv'd by the Courtiers that ſtood by him; but in a little time it diſappear'd again, as if it had ſunk into the Sea, which *Phænomenon* I attributed to this, *viz.* That that Coaſt lying but a little too far off to be ſeen before, the Air interpos'd betwixt His Majeſty's Eye and the Shoar, being fill'd with Vapours and ſubterraneal Steams, was render'd more refractive than before, by the help of which new Refraction, the *French* Coaſt which lay beyond it, was as if it were lifted up, in reference to the ſight, and ſo became viſible as long as that new Refraction laſted; but when thoſe Steams were diſſipated, they preſently diſappear'd: In favour of which Conjecture I alledg'd, that a piece of Gold being laid in the Bottom of a Cup, and the Eye ſo plac'd, that the Object is but juſt hid from it, upon pouring in Water, the Object will, without removing the Eye, become viſible,

visible. The Surface of the Water, which is a thicker *Medium* than the Air, refracting the Rays, and changing them from a Perpendicular to an inclin'd Position, so that they are caus'd to fall upon the Pupil.

The Duke of *York* told me, that he was not a little surpriz'd in *Scotland*, that contrary to the common Observation, by Country men in other Places, a Morning in which the Sky was red, was succeeded with a fair Day, it being usual in those Parts. It is observ'd, that when the Redness is pretty near the Ground, and appears with narrow streaks intensly red, it signifies bad Weather; but if it be elevated, and the Wind *Easterly*, it foretels a fair Day.

Capt. *James* in his *Northern* Voyage observ'd, that by Reason of these Refractions, the Sun seem'd to rise 20 Minutes too soon, and to set 20 Minutes too late; and this he learn'd by calculating of it's rising and setting with good running Glasses, and comparing that Calculation with the Stars when come to their Meridian.

March. This Evening the Moon rose in the Form of an oblong Oval along the Horizon.

April. Tho' on a clear Sunshiny Day I could not see an Island which lies but 4 Leagues off *South-South-East*, yet when the Weather was misty, it might be seen from the lowest Place. The Height of it being taken Instrumentally, standing near the Sea-side, it was 34 Minutes, the Sun bing 28 Degrees high, which shews how great the Refraction was; yet it will not be amiss to note here, that I have seen the Land elevated

vated by Refractitious Air, when the Sun hath rose presently round.

Jan. 6. The Latitude was 51, 52, which Difference was occasion'd by a greater Refraction.

Jan. 21. The Sun rose like an Oval, seeming as long again as it was broad, but as it rose higher, it gradually recover'd it's roundness.

In *Poland* near *Warsaw June*, 16$\frac{83}{}$ we had clear Weather, and extreme cold, and for two Days we observ'd the Sun and two Parhelions, from near 10 to almost 12 a Clock, yet the Air was free from Clouds, and so clear, that we could perceive Icy Spangles flying in it. And where, as usually in Frosty Weather, any smooth Iron or rather Metal, being brought into a warm Room out of the open Air, first a Dulness, and then drops of Water will appear in the Glass; at this time there appear'd something like a hoar Frost. Whether subtle Particles of Cold will penetrate polish'd Metal or not, I will not determine, tho' the sudden Adhesion of ones wet Finger to Iron, seems to favour the Affirmative.

The same Month returning back from *Warsaw*, I saw the Sun rise with a large Pillar, colour'd like a Rainbow, perpendicular over it, out of a clear Horizon.

In *Cornwall* it was observ'd, that in driving home Levels or Links, the Waters partaking of the Minerals, are sometimes sanative, and at other times cause Wounds.

One who travell'd over the *Alps* observ'd, that in the Clouds below, which seem'd big with Thunder

Thunder, ſomething mov'd up and down like a ſhining Fiſh in muddy Water, the Lightning appearing through the Cloud. It hath been obſerv'd on the Coaſt at *Naples*, that in the Morning at Sun riſing a Town which was at ſome diſtance off, ſeem'd to have two Steeples, tho' it really had but one in it; and another Morning, the Refraction was ſo ſtrong, that there ſeem'd to be a very fair Town beyond it, wall'd about; and adorn'd with Towers and Steeples very delightful; which very Town diſappear'd when the Sun was roſe higher above the Horizon.

A dry blighting *Eaſt* Wind, which Country People call a red Wind, cauſes an Opacity or Thickneſs of the Air, like Vapours, which continuing for two Years together, not only blaſted the Fruit, but the Leaves of the Trees juſt in the *Tender*. Mr. *J. T.*

That the Air is ſometimes Clear and Tranſparent, and ſometimes darker and more clogg'd with terreſtrial Steams, is a common Obſervation. But it hath been ſometimes obſerv'd in *Ruſſia*, that in a clear froſty Air, the Stars have appear'd to be much more Numerous than at other times.

Captain *James* hath obſerv'd, in *Charlton* Iſlands, which, tho' of the ſame Latitude with *Cambridge* almoſt, is but little warmer than *Nova Zembla*; that in *January* the Firmament appear'd fuller of Stars by two Thirds than before; The Cloud in *Cancer* appearing full of Stars, and a great many ſmall ones amongſt the *Pleiades*: But the Moon riſing about Ten a Clock, a quarter of them was not to be ſeen; the Wind

for

for most part of the Month being *Northerly* and very cold: And the like hath been obſerv'd by the *Ruſſian* Emperor's Phyſician.

The Duke of *York*, when he was High Commiſſioner in *Scotland*, ſent me word that he had obſerv'd the Sky ſo clear, that the Stars afforded Light enough to read by; and that ſeveral Fleaks of Light extended themſelves from the Horizon, like ſo many Tails of Blazing Stars; and paſſing betwixt *Charles's Wain* and the *North* Star, ſeem'd to terminate over our Heads: This was obſerv'd in *December*.

TITLE XXI.

Of the Operation of the Air on the Conſiſtency of Animal Subſtances.

The Effects of Air on Animal Subſtances.

IT is generally believ'd by thoſe, that judge of things by their Senſes, that ſince the Air is an inviſible Body, it acts only upon others, by it's manifeſt Qualites, *viz.* Heat and Moiſture: But I am apt to believe, that it hath other Faculties, amongſt which, ſome may be call'd Generative and Reſtorative, and others Corruptive; and that not only in reſpect of Animals, and other Bodies of a ſlighter Texture, but alſo of Salts and Minerals.

It hath been obſerv'd, that when *Cheſhire* Cheeſes have been carry'd from hence to the *Eaſt-Indies*, without being kept in leaden Boxes fitted to them; thoſe that have been cut under the Line, were dry on the outſide, but unctuous and ſoft in the Middle, as if all the oyly Parts wanting

wanting in the outside, were shrunk back thither. But those that were cut when they had pass'd the *Torrid Zone*, and came into the Temperate Zone, were uniform and good enough.

It is observ'd, that in *Peru* as well as *Egypt*, where it seldom rains, that Bodies are not subject to corrupt. In the Country last mention'd it is likewise observ'd, that the Air abounds with Nitre.

It hath been observ'd, that under the Line, not only Biskets have been alter'd, but that most of the Meat, and even Salt Meat hath been much impair'd; but that their Water which was fresh, would be as clear and sweet as when first put into the Casks.

Silk Stuffs that have been brought to *Jamaica*, I am told, have rotted without losing their Colour, by being expos'd to the Air.

TITLE XXII.

Of the Operation of the Air *on the Consistency of vegetable Substances.*

The Effects of the Air on consistent Bodies.

A Piece of Limon having been kept a Year and some Months in a Receiver, with a mercurial Gage; it kept it's Colour pretty well, as well as it's shapes, except, that, the upper side was a little depress'd, the Liquor which fill'd it up before stagnating upon a Glass Plate, which was adapted to the Receiver. When the Receiver was open'd, the external Air rush'd in with a considerable Noise; whence it was evident,

dent, that all the Air the Limon had yielded in that time, was not sufficient to fill the Cavity of the Receiver. Neither the Limon nor the Juice were mouldy or ill tasted; so that it made me think, that Mouldiness cannot be well produc'd without a Concurrence of the Air. The Liquor was acid, but clear and without *Feces*, being of a Colour betwixt brown and red: It turned Syrup of Violets into a Purple Colour, and corroded Fragments of red Coral in the Cold.

It hath been observ'd, that Lozenges, which a Scholar frequently carry'd in his Pockets, were dissolv'd when he came near the Line; but recover'd their old Consistence, when much past it.

TITLE XXIII.

Of the Operation of the Air *on consistent mineral Substances.*

The Effects of the Air on mineral Substances.

IN drawing Copper out of deep Mines in *Sweedland*, I am inform'd, they use Ropes made of Leather, Links of Iron being subject to break with the Coldness of the Air and the Weight of the Ore.

It hath been observ'd, that Glasses kept half a Year, tho' well neal'd, have broke in pieces, and froze of themselves; the Cracks partly depending on some Particles of Salt, which had not undergone a sufficient Comminution.

I am told, there is a House in *Suffolk* near the Sea, in which, tho' it is but 8 Years old, the Iron Bars are swell'd, and so rotten that they'll crumble

crimble away; The Winds which blew upon those Windows in which they were being *Southward*; and I am likewise told, that Iron Bars drench'd in Sea Water, and after expos'd to the Air, were so far impair'd, that when hammer'd, great Flakes would fly off them.

Purbeck and *Blechington*-stone will moulder away in the Air; But those dug up at *Painswick*, near *Glocester*, will, by being expos'd to the Air, change their Primary Softness for a Crust hard and Glassy Marble, which penetrates but a little way into it's Substance, but is generated sooner, the oftner it is wash'd.

TITLE XXIV.

Of the Air *in reference to Fire and Flame.*

CAndles which burn in Grooves furnish'd with Air Shafts, will sometimes continue burning 8 Fathom deep or more. When they come into close Ground, tho' Candles will burn for a while, yet when the Dust rises, they go out.

Experiments touching the Relation betwixt Flame *and* Air.

THE burning of Candles, *&c.* under a Glass Bell, as also Spirit of Wine, Matches, Touch-Wood, Sponck, *&c.* The keeping of Animals under a Glass Bell, whilst the Flame is burning.

The burning of Bodies to Aſhes in ſealed Glaſſes, as alſo in exactly clos'd Receivers; Cotton burnt in a ſeal'd Glaſs.

The burning of a Mixture of Flames under Water in an *E. R.* as alſo of a ſaline Subſtance, and likewiſe of Salt *Petre.*

A Piſtol not firing in an *E. R.* An Experiment of burning Gunpowder.

The burning of Spirit of Wine and Oyl of Turpentine in Glaſs Veſſels with ſlender Necks.

TITLE XXV.

Of the Air *in reference to Fermentation.*

Of the Air in reference to Fermentation.

RAiſins being enclos'd in an exhauſted Bolt-head half full of Water, and ſet on a digeſtive Furnace, preſently began to ferment; and ſwimming upon the Liquor afforded Bubbles, which were gradually fewer; and at laſt a Sediment appeard in the Bottom. The Top of the Bottle being accidentally broke, the External Air ruſh'd in with ſome Noiſe, and the Surface of the Liquor was cover'd with Froth like Bottle Drink, and I thought I perceiv'd a viſible Fume come out of the Glaſs, which had a Languid Smell. The Liquor had a high Tincture of the Raiſins, and was of a better Conſiſtence than that of Water.

TITLE XXVI.

Of the Air as the Receptacle of Odours.

TITLE XXVII.

Of the Operation of the Air on the Odours of Animal Substances.

SOur Grapes having lain 3 Years in *Vacuo*, were not mouldy; but the Surface of the uppermost was discolour'd with a Tartarous Efflorescence. The Grains had a musty Smell; but the Liquor tasted Acid, and would corrode Coral in the Cold. The Gage scarce discover'd any Air produc'd. *Of the Effects of Air on Odours.*

In *Madrid* I am told, tho' they throw their Excrements into the Streets in the Night, yet the stink is not very much the next Day; nor will dead Animals stink long there.

TITLE XXVIII.

Of the Operation of the Air on the Odours of vegetable Substances.

LArge Pieces of Oranges having been three Years included in *Vacuo*, their Rinds were, on their Surface, almost black; they yielded very little Liquor; being neither mouldy nor putrid.

TITLE XXIX.

Of the Operations of Air on the Odours of Mineral Substances.

TITLE XXX.

Of the Operation of Air on the Tastes of Animal Substances.

MR. *Nickson* told me, that Meat might be preserv'd in frosty Weather, all Winter without Salt; but, if dresst when froze, would not relish well.

TITLE XXXI.

Of the Operation of Air on the Tastes of Vegetable Substances.

TITLE XXXII.

Of the Operation of the Air on the Tastes of Mineral Substances.

TITLE XXXIII.

Of the Operation of the Air on the Colours of Animal Substances.

Of the Effects of Air on Colours.

THE Air influences Colours so much on black Taffety, that in *Brasil*, after it hath

hath been worn a few days, it becomes of an Ironiſh Colour; but if it be kept from the Air, the Colour fades not.

In a Particular Region in *Brazil*, 50 Leagues beyond *Parigna*, White People turn Tawny; but a little beyond that, they recover their Colour again.

Upon *Charlton* Iſland, there is a ſort of Birds call'd *Partridges*, which are white in the Winter, and gray in the Summer.

TITLE XXXIV.

Of the Operation of the Air on the Colours of Vegetable Subſtances.

I Am told, that moſt Trees in *Jamaica* acquire a Greenneſs, when newly cut down, on that Part which is moſt expos'd to the Air; and that *Lignum Vitæ*, when green, is as ſoft as Oak. Several Trees which are ſoft when cut down, afterwards grow hard; eſpecially the Cabbage-Tree, which preſently hardens, and the Pith rotting out, it ſerves for a Pipe about 100 Foot long, which will not corrupt under Ground, but grows as hard as Iron.

The Juice of Aloes Plants, which in the Iſland of St. *Jago* was clammy, bitter, and of a dark Colour; under the Line loſt it's Bitterneſs, and acquir'd a green Colour.

Stains are moſt eaſily got out of Linnen, at thoſe times of the Year, when the Fruit with which they were ſtain'd flouriſh.

TITLE XXXV.

Of the Operation of the Air on Mineral Substances.

ONE Part of *Lapis Calaminaris* being mix'd with four of *Salt-Petre*, was kept some hours in a vehement Heat in a Crucible, by which means the Matter being alkaliz'd, Water was pour'd upon it, which made a muddy red Tincture; which being set in a Wide-mouth'd Glass in a Window, it became green and more diaphanous than before; but in a few Days, it became a transparent Liquor, a Powder subsiding which was red like Brick-dust.

Spirit of Vinegar receiv'd no Tincture from Copper boil'd in it; but being expos'd to the Air in a broad Glass, in which part of the Filings were not cover'd with the *Menstruum*, some acquir'd a greenish blew Colour; but those Filings which were quite cover'd with the *Menstruum*, acquir'd no such Colour, till by evaporating it, they were expos'd to the Air.

A Solution of *Sal Armoniack* in Water, being pour'd on Filings of Copper, contain'd in a slender Viol, and on another parcel contain'd in a Wide-mouth'd Glass, that in the latter was much more tinged than the other; And what was remarkable was, that tho' the lower Part of the Solution was of a deep Blew, yet it was cover'd with a Film of a differing Blew, like that of the finer sort of Turcoices.

Three

Three Drops of Spr. *Sal Armon.* being put upon two diſtinct parcels of Filings of Copper, which were on two pieces of brown Paper; one was expos'd to the Air, and the other ſhut up in *Vacuo*; that in the open Air tinged the Paper with a Blew, the other remain'd ¼ of an hour without any Effect; but when it had been expos'd to the Air as the other, it tinged it Blew.

A yellow Urinous Spirit of the Lees of Wine, having Filings of Copper thrown into it, drew from them a pleaſant green Tincture, which in a few days became yellow; but by being expos'd to the Air, it turn'd green again; yet regain'd it's Yellowneſs when it had been ſhut up for ſome time. I have ſometimes obſerv'd, that tho' by being kept from the Air, this Tincture would loſe it's Greenneſs, yet it would ſometimes renew it again, without being expos'd to the outward Air.

Spirit of Amber extracted a green Colour from Filings of Copper. And tho' Spirit of Honey uſes to turn Blew, when expos'd to the Air, yet this Evening it continu'd yellow an hour. And I have obſerv'd, that tho' a Tincture often vary'd it's Colour, being ſometimes Colourleſs, and at other times of a deep Blew, yet another Bottle, which contain'd the ſame Mixture, did not ſo.

It hath been obſerv'd about a Mountain in *Wales*, that there are ſeveral Stones, which tho' of a Rufty dark Colour, yet when expos'd to the Air, in a few years they become white.

Mercurius Sublimatus Dulcis and *Vitriolum Romanum*, being kept in Papers apart near two Years, the Sublimate look'd like Antimony, and the Superficies of the Vitriol had acquir'd the ſame Colour.

TITLE XXXVI.

Of the Air deſtroying or introducing other leſs obvious Qualities into Animal Subſtances.

TITLE XXXVII.

Of the Air deſtroying or introducing other leſs obvious Qualities into Vegetable Subſtances.

The Effects of the Air in producing Putrefaction.

THE Heat and Moiſture of the Air in *Guinea*, hath been obſerv'd ſo much to promote Putrefaction, that Maggots were found in white Sugar; ſeveral Drugs have loſt their Virtues; and Ointments became verminous: And in the Iſland St. *Jago*, the ſweet Meats contracted ſuch a Moiſture in one Night, that they were forc'd to dry them in the Sun.

The *Oxford* Air being generally moiſt, agrees not with ſplenetick Bodies. Mr. *J. T.*

Air too dry, tho' hot, produces not divers Inſects, ſuch as white Snails and Fleas, which are bred in wet Summers.

TITLE XXXVIII.

Of the Air deſtroying or introducing other leſs obvious Qualities into Mineral Subſtances.

Leſs obvious Qualities introduc'd into Minerals.

Obſervandum etiam quod Antimonium Diaphoreticum quocunq; modo, ſive cum ſolo Nitro aut addito etiam Tartaro, paratum ſit, tractu Temporis Aeri expoſitum, pravam ac quaſi malignam induat Naturam, ſumptumq; intra, Cordis & anguſtias, Cardialgias, Lipothymias, vomituſq; ſimilia prava ſymptomata procreet, qua facile tamen evitabimus, ſi vel ſingulis diebus vel tribus Menſibus recenter illud conficiamus, vel jam paratum Antimonium Diaphoreticum vetuſtum, addita portiuncula Nitri, aut etiam abſq; Nitro per unam vel alteram horam, Vulcano tradamus penituſq; igniamus, iterumq; ſi Nitrum additum fuerit, edulcoramus, & parumper reverberemus. Zwelf. p. 800.

The Earth of *Ægypt* preſerv'd dry, at the 17th of *June* begins to increaſe it's Weight, which ſtill increaſes more as the River augments.

Ceruſs of Antimony, I am told, as well as *Am. Diaphoret.* acquir'd a vomitive Quality, tho kept in a ſtopp'd Glaſs long.

Thoſe Pots which are made of Earth, which hath lain 4 or 5 Years dry, bear Fire beſt; and it is obſerv'd, that thoſe Bricks which lie at the Tops of Brick-kills, bear Weather worſt, being not ſo well burnt as the others.

TI-

TITLE XXIX.

Of the Air in reference to the Propagation and Vegetation *of Plants.*

The Effects of the Air in respect of Generation.

IT hath been obſerv'd, that that ſide of the *Pyrenean* Mountains, which reſpects *France*, is flouriſhing and verdant, tho' at the ſame time, the other ſide which reſpects *Spain*, is barren, and looks diſmally, being blaſted and parch'd with noxious Winds.

TITLE XL.

Of the Effects of the Air in Reference to the Generation, Life *and* Health *of Animals.*

The Effects of the Air in reſpect of Generation.

DE vita igitur ac morte, & iis pene omnibus quæ huic conſiderationi affinia ſunt, dictum eſt. De ſanitate verò morboque non ſolum Medici, ſed & Phyſici eſt, cauſas quadantenus referre. Quatenus verò hi differant, & quatenus diverſa contemplantur ignorare non convenit. Equidem quod confinis ſit quadantenus hæc Medici Phyſicique Tractatio, & res ipſa teſtatur. Nam & Medici, quicunque paulò elegantiores & diligentiores ſunt, de natura dicunt, & artis ſuæ principia inde ſumere dignantur; & Phyſici omnes fere, qui concinnitatis aliquid habent, tractationem naturæ uſque ad medicinam perſequuntur. Ariſtot. de Reſpirat. *cap.* 21. & *parag.* 87.

The

The Temperature of the Air depends on ſubterraneal and terreſtrial Steams mix'd with the Air, and ſhuffled amongſt one another.

The laſt great Plague was foretold by one who had a great Swelling in his Groin the Year before, the like having happen'd to the ſame Man once before.

That there are Changes in the Air which depend on the Motion of it barely, I am perſwaded, not only becauſe it ventilates thoſe places it paſſes through when in Motion, and drives away ſtagnant Air; but I am told that in *Languedoc*, that if, when the Silk-Worms had eaten their fill, it happen'd to Thunder, the Air being put into a diſturb'd Motion, the weakeſt of them would die.

Several Horſes being let down a third part of the way into Mines 1000 Foot deep, ſome of them dy'd; but others ſurviv'd, and were there employ'd without any inconveniency to Reſpiration, tho' the Receptacles they wrought in were furniſh'd with Air, only from the Groove by a moderately big Shaft: I am told, the deepeſt Mine in *Bohemia* is 2000 Foot deep.

I am inform'd by one who liv'd at *Tripoli* and *Guinea*, that the Air is not conſtantly unhealthful there, but that the Men are ſometimes ſuddenly taken with Fluxes and Fevers, which frequently kills in 48 hours.

The Air in *Ruſſia* in the Winter when the *North* Wind blows, is too thick for Reſpiration; And I am likewiſe inform'd, that when our *Europeans* paſs the *Line*, all the Lice about them aſcend into their Heads, but diſperſe themſelves again when they have paſs'd the *Equator*

tor a good way; but they uſually die under the *Equator*.

It it obſerv'd, that in *Scotland* Agues are very rare, tho' at the ſame time they are very riſe in *England*.

Roderici Fonſ. de Sanit tuend. pag. 105, 106.

Aer autem corrigitur cauſa corruptionis ablata, & quod jam inductum eſt mali extinguendo; ſi igitur ex nimio humore Aer putreſcit, ignibus accenſis qui omni putredini remedio ſunt, exſiccandus, ſic ignes, per vias & domus fiant ex odoratis plantis, qualis Laurus eſt, Mirtus, Pinus, Cupreſſus, Roſmarinus, & reliquæ ejus generis, qua ratione peſtem Athenis Hippocrates extinxit; vapores præterea maligni per Aerem ſparſi, diſſipandi ſunt, id quod à magnis ventis fieri ſolet. Sic Olyſiponi, cum trium dierum ingens procella veniſſet peſtis extincta nuper eſt; in Maroco ingens peſtilentia vento quodam evanuit; qui veluti e fornace (adeo calidus erat) exire videbatur, Aerem autem nos imitando ventos commovere poterimus, ſi bombardarum ſtrepitus fieri curemus; ſi vero vapores ex paludibus, ac ſtagnantibus aquis fieri videntur; eas reſiccare aut novare oportet frequenter, maximè per æſtatem. Renovantur autem novis ſupervenientibus aquis quas è fluminibus per canales traducere oportet; aut ſiccanda ſunt factis rivulis, & foſſis per quæ ſuperfluant ad flumina; quod cum primus magnus Etruriæ Dux Coſmus Piſis feciſſet, & magna animi contentione, tunc faciat Ferdinandus, factum eſt, ut ſaluberrimus ejus urbis Aer per omne annitempus ſit redditus; verum ſi cadaverum inhumatorum multitudo Aerem inficit; magna & profunda facta fovea ſepeliantur, ſi ab immunditiis, & excrementis, qua per urbem domos ſpargunter, id quod, ut reor Biſantii, & Olyſiponi, in cauſa eſt,

eſt, cur peſtis adeo ſeviat, ac duret, mundare oportet omnia; vias at domus quotidiè, vel ſaltem ſemel in ſeptimanâ repurgande.

1. Joh. Beguinus in Tyrocin. Chimic. lib. 2. cap. 13. *Dignum admiratione eſt, quod quamvis in vicinia Hydriæ Comitatûs Goriciensis, ubi reperitur copioſe Mercurius, ſingulis ferè annis Lues peſtifera graſſatur, illa tamen ſemper immunis ab hac manere ſoleat, idque viri provectæ ætatis ſe obſervaſſe, & à majoribus ſuis accepiſſe, mihi ſanctè confirmarunt. Hinc patet, Mercurium eſſe ſummum omnis putredinis ac corruptionis alexipharmacum.* 2 Michael Majerus in luſu de Mercurio. *Argentum vivum eſt plurimorum morborum alexipharmacum, & ut teſtantur quidam, ipſius Peſtis (cum eo loco ubi Mercurius effoditur, & tractatur, nunquam aut rariſſimè hoc Contagium graſſetur) dummodo maneat in ſuâ propriâ naturâ, & non à ſalibus aut aquis corroſivis inficiatur, ac venenoſus reddatur.*

Several Clove Trees growing in the Iſland of *Ternate*, in the *Eaſt-Indies*, after they were all cut down, it was very unhealthful, the Exhalations from them being wanting to correct the noxious Steams of a neighbouring Vulcan. So that tho' the Inhabitants of *Batavia* formerly reſorted thither for Health's ſake, they now are ſome of them forc'd to go to ſupply the Deficiency of men, which the Unhealthineſs of the Place makes, to ſupply their Garriſons.

It is obſerv'd at *Tangier*, that new Comers are uſually feverish for ſome time, eſpecially if the *Eaſt* Wind blows.

Seve-

Several Ants included in a Receiver, ran about till it was exhausted, and then lay as dead, but recover'd when Air was let in again, two or three times successively.

Relatione della Provincia di Malavar. pag. 64 & 65.

Si Patrono queste barche dalla costa della pescaria, e vanno all isola di Ceilam, nella costa della quale per la lunghezza di venti miglia, tre sole miglia lontane da terra, sette braccia abbasso arrivando sino alli dieci nel fondo, si ritrova infinita quanta di madreperle, escono per questa pesca le barche la matina col vento di terra, & arrivando al posto delle madreperle, gettare l' ancore, e fermarsi in quel posto, cominciano a tuffarsi nel mare i marinari, de quali ogni barca ne ha quindeci, e venti, e ciascuno di essi si lega nel mezzo, con una fune, della quale ha cura uno, che resta in barca e con un' altra fune legandosi una pietra alla gamba, un' altro ha pure cura di quella, e cingendosi un' sacco di cuoio dinanzi, mettendosi le guante alle mani, così legato si tuffa con violenza nel mare, lentando quelli le funi, e col peso della Pietra, va con grandisi violenza giu, & arrivato ch' e, scioglisi dalla gamba quella fune, con la quale sta legata la pietra, resta egli libero, & la pietra viene subito tirata sopra da quello, che n' ha cura, et il marinaro poi comincia con molta sollecitudine à pigliare quelle madreperle, che li vengono dinanzi, e le mette nel sacco, e sentendosi mancare la respiratione, tocca la fune, con la quale sta legato nel mezzo, e quello subito con grandisi velocità lo tira et arrivando nella barca, scaricando le madreperle ripiglia fiato, e dopo torna a legarsi di nuovo la pietra, e dinuovo si tuffa come sopra è detto, e sempre così per tutta la giornata. Et è tanto

faticosa

faticoſa queſta peſca, eh' eſſendo, tanto profunde le Madre perl nel mare, molti mancando loro la reſpiratione ſi trovano affogati.

In the Iſland *Johanna* it is obſerved, that if a Stranger lies all Night there, he will die of a Putrid Fever in a few days; but tho' they go but a Mile upon the Sea every night in a Boat, they are generally ſafe. The Iſland is very hot in the Day, but cold after Sun-ſet; and it is ſuppos'd, that the Unhealthfulneſs of the Place depends on Exhalations which plentifully ariſe from a vaſt Number of Plants that grow in the Iſland, which being condens'd at Night, infect the Maſs of Blood. There is one Hill in the Iſland very high, which is ſeldom ever free from Fogs or Clouds, which vary in their Height according as the Weather alters.

On the Coaſt of *Cormandel*, and moſt Maritime Places of the *Eaſt-Indies*, there are ſometimes ſuch Fogs, that the Inhabitants for the time, are forc'd to keep the Windows and Doors of their Houſes faſt ſhut, there being at thoſe times little or no commerce, tho' the Weather is very hot.

At *Balaſſore* in the Bay of *Bengale*, and other Places of that Country, after great Raius the Air is ſo much corrupted, that the Smell is very nauſeous to the Inhabitants, which may be occaſion'd by a great number of Frogs, left on dry places after Inundations, and putrify'd by the Heat of the Sun. At that time there is great Mortality amongſt the Natives, chiefly by violent Fevers.

When

When ſick People are ſet on ſhore at St. *Helena*, they are generally much better in a few days, tho' before they were very weak.

Le chemin plus court de Moſul a Bagdad, eſt par la Meſopotamie; mais on n'y trouve aucun Village; & le Samiel y regne tout l'Eté depuis Moſul juſques a Sourat; ce qui oblige a prendre l'eau, ſur le Tigre où ce vent ne Souffle point. Le nom de ce vent et compoſé des mots, Sam et jel, *c'eſt a dire poiſon et vent comme qui diroit vent de poiſon, Ce pourroit être le vent urens, dont parle Job* xxvii. 21. *Lorſque quelqu'un a reſpiré ce vent, il tombe mort ſubitement quoi qu'il en ait quelques uns qui ont le temps de dire qu'ils brûlent au-dedans. D'abord qu'on eſt mort, on devient tout noir, et ſi on tire le mort par le bras où par la jambe où par un autre endroit la chair quite les os et reſte entre les mains de ceux qui la touchent. Thevenot dans le Bibliotheque Univerſel Tom.* xiii. p. 266.

Dr. *Collins* told me, that in *Muſcovy* their Horſes are ſubject to a very foul Diſeaſe, from which they defend them by keeping Goats in their Stables.

The Plague generally at *Smyrna*, but eſpecially *Aleppo*, at the End of *June*, or the beginning of *July*, degenerates into other Diſtempers; the infectious Particles of the Air, then being diſſipated, and depriv'd of their pernicious Qualities. For a like Reaſon the Offenſive Smoak of a Candle being further rarifi'd by the Application of Smoak, loſes it's ill Scent and other ill Qualities; beſides, it may be further offer'd, that the Heat of the Summer, may raiſe

raiſe other ſaline *Effluvia* from the Earth, which mixing with the former, may correct and alter their infectious Qualities. And as for the Reaſon why the ſame does not happen at other places as well as *Smyrna*, it may be anſwer'd, that the Concurrence of Cauſes may be the Reaſon of the Difference, ſince ſome Soils may emit Peſtilential Vapours with a ſleight Heat, which others may correct when rais'd by a greater; for a like Reaſon to which, the Plague in *Grand Cairo* ceaſes, the Earth, upon the ſwelling of the River *Nile*, emitting Nitrous Vapours, which correct the Peſtilential ones.

To ſhew, that the Qualities of the Air may be very much alter'd by the ſupervening Coldneſs or Heat of it, I ſhall alledge the following Experiment, *viz.* That equal parts of Allum and Nitre, being diſſolv'd in the ſame Portion of Water, when the Liquor was pretty well evaporated, and an earthen Veſſel which contain'd it, was ſet in the Cold, the Alum was firſt coagulated into ſeveral octoedrical Grains, and upon a further Evaporation, at the laſt the Nitre ſhot into very fine little Cryſtals, of a Figure natural to ſuch Salts. From whence we may conjecture, that ſeveral Salts which act joyntly, may be ſo ſeparated by ſupervening Qualities in the Air, as to act ſeparately.

A Mouſe lived ten Minutes with a Quarter of Air, and three afterwards.

TITLE XLI.

Of Heavy Bodies sustained in, or taken up into the Air.

TITLE XLII.

Of Dew.

TITLE XLIII.

Of Rain.

IT hath been observ'd, in the Country of *Campen*, that Rain falling into Pits, which were dug to a sort of Quicksand, would in a little time form a Clay, which skilfully handled, would yield good Iron. The Waters in that Country are obser'd to leave a strong Matter at the Bottom when distilled, notwithstanding the Rectification.

L. 1. *c.* 8. De mont. *Bohemiæ*, *p.* 26. A *Mileſſow* monte temporum præſagia capiuntur.

'Quicquid erit, ſine fuco ſignificat, velut *Rotenburg*, Sileſiæ compaſtum appellant, perinde '*Mileſſow* Temporum prognoſtes, jure merito 'dici poteſt. Vidi ex proximo totum aliquando 'Montem denſiſſimis Nebulis contectum, et 'proxſus Imagine, qua Mons Sinai Moyſe in Ne-'bula latente depingitur, at cæteri circum Mon-'tes, innubes & hilares velut rerum gerendarum 'ignari ſtabant. Sol ipſe formoſiſſimus ibat; at 'accolæ locorum domum fugiebant, pecora urge-'bant, meque, ut domum protinus reciperem, pro-'perarem, & equos currum trahentes concitari ju-'berem

'berem monebant, neq; horæ quadrans interceſſit,
'jam Cœlum obduci, Sol contegi, eripi omnis
'aſpectus.

Immenſum Cœlo ruit agmen aquarum *Virg.*
——ruit arduus Æther,
Et Pluvia ingenti ſata letæ, boumq; Labores.

'Diluit, implentur foſſæ, & quæ Divinus
'Poeta proſequitur. At contra etiam accidere
'vidi, ut cæteri fumârint Montes, *Mileſſow* ni-
'hil ſe commovente, nihil aut Nubilum, aut
'turbidum minanse; Incolæ rogati, nihil eſſe
'magnopere timendum à cæteris ſpondebant,
'hunc unum intuendum eſſe, horum Nubila om-
'nia à *Mileſſow* quodammodo devorari.

TITLE XLIV.

Of Hail.

ON ecrit de l'Iſle en Flandres le 25 May, ſtyle nouveau, qu'il tombe dans cette ville la une graiſle dout les moindres grains eſtoient comme des œufs de Pigeon. Cet orage a paſsé ſur la Citadelle & la ville, & na pas laiſsé une vitre entiere du coſte du vent: les maiſons ſont toutes decouvertes, & les arbres rompus, les bleds coupez, & les perdrix & les lieures morts. On a peſe pluſieurs grains de cette graiſle, dout les uns eſtoient d'un quarteron, de demi livre, de trois quarteron, et les plus gros d'une livre & d'avantage. Il y en avoit un entr' autres qui avoit dans le milieu une eſpece de matiere brune qu'on mit dans le feu, qui fit faire un grand bruit. Il y en avoit un, qui eſtoit diaphane, lequel eſtant mis aupres du

feu, fondit tout auſſi toſt comme du plomb, quoy qu'il fut beaucoup plus dur que les autres.

TITLE XLV.

Of Snow.

TITLE XLVI.

Of other things falling out of Air.

EO ipſo anno quo Dux Eboracenſis poſtremo rediit e *Scotia Londinum*, depluere tanta copia piſciculi halecibus colore, figurâ, ſapore quam ſimillimi in ſuperiori Gallocidiæ in *Scotia* parte non procul à mari, ut duo terræ jugera ad *Robertum Murray* de *Brughton* equitem pertinentia nunc *Londini*, ut audio, degentem, cooperuerint. Rem autem totam ſereniſſimo Duci Eboracenſi prius de eadem ab eo interrogatus, quod tum certior aliis de hâc pluvia factus eſſet, tanquam teſtis oculatus, ut qui aliquos horum piſciculorum videram, confirmavi: is porro ingenioſiſſime, ſummâque veri ſpecie nodum ita ſolvit, ut diceret hos piſciculos unà cum aquis furentium ventorum gyro in turbinem actis evectos eſſe nubes, è quibus non procul inde pondere rurſus ſuo relapſi fuerint in vicinam terram.

TITLE XLVII.

Promiſcuous Experiments and Obſervations of the Air.

TITLE XLVIII.

Deſiderata *in the Hiſtory of the Air, and Propoſals towards ſupplying them.*

THE

THE

WORKS

Of the HONOURABLE

ROBERT BOYLE Esq;

EPITOMIZED.

BOOK IV.

CHAP. I.

Experiments and Observations about the Mechanical Production of Tastes.

THAT Taste, which is a Quality of a Body, by which it is enabled to cause such a Sensation upon our Sensory, may be caus'd, by the Peculiar Size, Shape, Motion, and mechanical Texture of a Body will appear from the following Instances, whether they be simple or compound Bodies.

EXPERIMENT I.

To divide a Body almost Insipid, in two Bodies of very strong and very different Tastes

Two Corrosives obtain'd from an insipid Body.

SAlt Petre refin'd, tho' almost an Insipid Body, distill'd by the way of Inflammation, or by the Help and Addition of a Tastless Clay, will yield a nitrous Spirit, so sharp and corrosive, that it will dissolve Metals; and a corrosive fixt Salt, different in Taste from the former, and this will dissolve Substances that the other will not work upon, and precipitate several Metals, and other Concretes, out of those Solutions, made of them by the Spirit.

EXPERIMENT II.

Of two Bodies, The one highly Acid and Corrosive, and the other Alkalizate and Fiery, to produce a Body almost insipid.

An insipid Body produc'd from two Corrosives.

IF a sufficient Quantity of Spirit of Nitre, be dropp'd upon the fixt Nitre made *per Deliquium* till it is satiated, upon a gentle Evaporation, it will afford a Salt Petre; and I have often obtain'd the like from Spirit of Nitre and Salt Petre, which new Taste I am apt to believe proceeds from the new Figure and Size of the component Parts, which they acquire upon a mutual Attrition in the Preparation. For as the Prismatical Figure of Salt of Nitre, by being broke and render'd more minute, may have a more free Access to the Organ of Taste, and by it's

it's new figur'd Angles be able to corrode it; these again uniting and forming Prisms may become as inoffensive to the Taste as before. So Wedges may be made of a piece of Iron, and those again united after a convenient Manner, may form blunt pieces of Iron again, and tho' a Stick cut in two, be inoffensive enough to the Hand, yet if violently broken, the ragged Ends will be apt to prick into the Flesh.

EXPERIMENT III.

Of two Bodies, the one very bitter, and the other extremely salt, to make an insipid Substance.

An Insipid obtain'd from a bitter and saline Body.

IF strong Brine made of Salt and Water, be cast upon Crystals of Silver dissolv'd in *Aq. Fort.* or Spirit of Nitre, the dry'd Mixture being brought to Fusion in a Crucible, and kept in that state a competent time, will afford a tough *Luna Cornea* insipid, which will not easily dissolve in more powerful *Menstruums* than Spittle.

PROPOSITION IV.

Of two Bodies, the one very sweet, and the other salter than Brine, to obtain an insipid Mixture.

An Insipid obtain'd from a sweet and a salt Body.

IF a just Proportion of Spirit *Sal Armon.* or Urine, be cautiously pour'd on a Solution of *Minium* in Vinegar or *Saccharum Saturni* dissolv'd in a proper *Menstruum*, if the Taste be not destroy'd by the Mixture, it will by being dry'd and flux'd as in the foregoing Experiment.

EXPERIMENT V.

Of an Insipid and Soure one, to make a Substance more bitter than Aloes.

A Bitter obtain'd from an insipid and a sour Body.

WHich is done by dissolving a sufficient Quantity of Silver in *Aq. Fortis*, to satiate the *Menstruum*; which if it be filtrated, and it's superfluous Moisture abstracted, it will yield Crystals more bitter; and no wonder, since if one touch the Powder of the Crystals with ones Finger or Nail, it would so stain them, that it cannot easily be remov'd.

EXPERIMENT VI.

Of an insipid Body and a highly corrosive one, to make a Substance as sweet as Sugar.

A sweet Body obtain'd from a corrosive and an insipid.

IF good *Aq. Fortis* be put upon *Minium*, and kept together in a gentle Heat, till the *Menstruum* is satiated, it will be as sweet as *Saccharum Saturni*, but the Ingredients must be both good.

EXPERIMENT VII.

Of obtaining without Addition from the sweetest Bodies, Liquors corrosive enough to dissolve Bodies.

A corrosive obtain'd from a sweet Body.

SUgar distill'd in a Retort, will yield a red Spirit, which being rectify'd, will come over clear and colourless; And the *Caput mortuum*

tuum will be altogether insipid; The Spirit is of a very penetrant Taste, and tho' taken to be a homogeneous Body, yet I have found it to consist of two Spirits, one of which would dissolve Copper; Yet these four Spirits being incorporated with *Minium*, would acquire a saccharine Sweetness, part of which they will dissolve in Digestion. And a like Spirit to this may be obtain'd from Hony.

EXPERIMENT VIII.

To divide a Body, bitter in the highest Degree, into two Substances, the one extremely sowre, and the other perfectly insipid.

THis is done by distilling Crystals of *Luna* in a Retort, with a strong fire in a Sand Furnace; by this means the Spirits being driven away, unite into an Acid corrosive *Menstruums*, leaving an insipid Substance behind them. *A sowre and an insipid obtain'd from a bitter Substance.*

EXPERIMENT IX.

To produce Variety of Tastes in one insipid Body, by associating it with divers Menstruums.

IF Zinke be dissolv'd in *Aq. Fortis*, *Aq. Regis*, Oyl of Vitriol, Spirit of Nitre, Spirit of Salt, distilled Vinegar, Spirit of *Sal Armon.* or of Urine, it will, by a Conjunction with those sapid Bodies, so alter their Textures as to produce a different Alteration in the Tastes of each. *Divers Tastes produc'd in an insipid.*

EX-

EXPERIMENT X.

To produce Variety of Tastes with one Menstruum, *by associating it with insipid Bodies.*

Various Tastes caus'd by an insipid.

Aqua Fortis with refin'd Silver will produce a Bitter; with Lead, a saccharine sweet Taste; with Tin, a different Taste, tho' not odious; with Copper, an abominable Taste; with Mercury and Iron, bad Tastes of different kinds. It will likewise produce different Tastes with Tin, Glass, Antimony, Brass, Emery and Zinke.

EXPERIMENT XI.

Of two Liquors, the one highly corrosive, and the other very pungent and not pleasant, to compose a Body of a pleasant and Aromatick Taste.

An Aromatick obtain'd from two corrosives.

MIX gradually an Ounce of good *Aq. Fortis* or Spirit of Nitre, with an equal Quantity of inflammable Spirit of Wine; and when they are well mix'd and grown cold again, if they be distill'd over together, they yield an acid corrosive Spirit of a vinous Taste and a pleasing Smell.

EX-

EXPERIMENT XII.

To imitate by Art, and ſometimes even in Minerals, the peculiar Taſtes of natural Bodies, and even Vegetables.

Natural Taſtes Artificially imitated.

WHatever is the Plaſtick Agent in the formation of Bodies of each diſtinct *Species*, to ſhew that the Nature of them depends on Mechanical Principles, I endeavour'd to imitate natural Taſtes Artificially.

Endeavouring to alter the Taſte, Smell, *&c.* of Oyl of Vitriol and Spirit of Nitre, I obtained a Liquor, which tho' at the firſt pleaſant, would at a certain point of time taſte like Garlick. And it hath been obſerv'd, that Muſtard-Seed put into Cyder to give it a brisk Taſte, made it ſtink like Garlick: And *Semen Dauci* fermented with Beer or Ale made it reliſh of Limon-Pills.

If Gold be diſſolv'd in a Mixture of *Aqua Fortis* and Spirit of Salt, and the Experiment be made haſtily, one may obtain a Solution or a Salt of an Auſtere Taſte like Slows. And the like Taſte I have obſerv'd in Gold volatilized; or diſſolv'd without any Tincture at all.

The laſt Inſtance I ſhall make uſe of, is this; Take a ℥j of *Orris* Root ſliced, and infuſe it in a Pint of *Canary* or *Malaga* Sack, till it hath given it the deſir'd Taſte and Smell, and then keep it in a cool place.

The

The same Method being taken with Claret-Wine and Cochinele, the Tincture was taken for good Rasberry-Wine, some of which retain'd it's Taste 2 or 3 Years.

A short Excursion about some Changes of Tastes made by Maturation.

Tastes produc'd by Maturation.

THAT several Fruits after they are gather'd, acquire a greater degree of Maturity, after they are separated from having any communion with the Soul of the Tree, is beyond doubt, since it is not only observ'd in *England*, that Apples, and Medlars become Mellow after they are gather'd; but the Fruit call'd *Bananas* in the *East-Indies*, are gather'd green, and hung up to acquire a greater degree of Maturity, and to ripen by degrees, and thereby undergo a Change both in Colour and Taste, and this I am told, hath been often found true in *America*.

And that the Texture and Consistence of Fruits may be much alter'd and vary'd by the Influence of outward Agents, mechanically working upon them, is evident in Cherries, which undergo a sensible Alteration by a small Bruise, by which the Parts are forc'd to work one upon another; and another Instance we have in Wardens set to roast in the Ashes. And I have seen a sort of Pears betwixt *France* and *Savoy*, which being stew'd a while in a moderate Heat, would be reduc'd to a juicy Substance of a lovely red Colour, and very sweet and

and luſcious to the Taſte; And ſome Pears by a moderate Compreſſure will loſe their hardneſs, and acquire a yielding Contexture and a pleaſant Taſte.

But not only vegetable, but more ſtubborn Salts may be alter'd by an inteſtin Motion of their own Parts, when diſſolv'd in Water, ſo as to become of a peculiar and a pleaſant Taſte.

And how in Vegetables, by an inteſtin Commotion of the ſaporifick Parts, a new Taſte may be produced, is evident in Juice of Grapes, which from a ſweet and ſpiritleſs Liquor, becomes a ſpirituous Wine, and after that a ſharp Vinegar, without any Addition.

CHAP. II.

Experiments and Obſervations concerning the Mechanical Production of Odours.

TO ſhew that not only Taſtes, but likewiſe Odours may be Mechanically produc'd, I ſhall lay down the following Experiments.

EXPERIMENT I.

With two Bodies, neither of them odorous, to produce immediately a ſtrong Urinous Smell.

THis will ſucceed if good Quick-lime and *Sal Armoniack* be ground together. *A Smell produc'd from inodorous Bodies.*

EX-

EXPERIMENT II.

By the bare Addition of common Water, to produce immediately a very strong Smell, in a Body that had no such before.

A Smell rous'd by an inodorous Body.

IF a good Quantity of Camphire be dissolv'd in Oyl of Vitriol, the Gum will lose it's Scent, but by an Infusion of cold Water the Camphire will emerge and smell strong as before.

EXPERIMENT III.

Of producing some Odours, each of them quite different from that of any of the Ingredients.

Odours produc'd different from those of the Ingredients.

TWO parts of Oyl of Turpentine being gradually mix'd with one of Oyl of Vitriol, the clear Liquor which they afforded, by Distillation in a sand Furnace, smelt very strong of Sulphur, and not of Turpentine. What remain'd behind in the Retort being forc'd, for the most part, over in the form *partly* of an Oyl and partly of a Butter, they smelt like distill'd Oyl of Bees-Wax.

EXPERIMENT. IV.

Of the Production of some Odours by local Motion.

I Know several Bodies inodorous, which being considerably hot, emit not odorous *Effluvia*, yet being put into a peculiar kind of Agitation,

gitation, emit a ſtrong Smell. And ſome Woods yield a powerful Scent whilſt in a Turner's Leath, which before were not odoriferous, as *Lignum Vitæ* and Beech-Wood, the latter yielding a fragrant Smell much like Roſes.

EXPERIMENT V.

By mixing a good Proportion of a very ſtrong ſcented Body, with an inodorous one, to deprive it ſpeedily of all it's ſmell.

IF *Aqua Fortis* not too much dephlegmed, be pour'd upon Salt of Tartar till they ceaſe to ferment; this Liquor evaporated, will yield Cryſtals like Salt Petre, but if diſtill'd or burnt, they yield very offenſive Fumes.

EXPERIMENT VI.

By putting a very ſtrong ſtinking Body to another of a Smell not ſweet, to produce a Mixture of a pleaſant and ſtrongly Aromatick Odours.

THis *Phænomenon* is afforded by the Liquor prepar'd in the XI Experiment of the preceding Chapter.

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EXPERIMENT VII.

By digesting two Bodies, neither of them well scented, to produce Bodies of a very subtle and strong fragrant Odour.

SOme Ounces of Vitriol digested with ℥j of *Spanish* Wine afforded this *Phænomenon.*

EXPERIMENT VIII.

By the bare Addition of a Body almost inodorous, and not well scented, to give a pleasant and aromatick Smell to Spirit of Wine.

EQual parts of Oil of *Dantzick* Vitriol and Inflammable Spirit of Wine, being digested together about a Month, and then being distill'd, yielded a very fragrant Spirit, which was sometimes so subtle, that, tho' distill'd with a gentle Heat in a tall Glass, it would fill the *Elaboratory* with Fumes; whence we may learn how much a Mineral Sulphur may be enobled with a vegetable Sulphur; and how much new Coalitions and Contextures may alter the Odours of Bodies.

EXPERIMENT IX.

To make the forementionʼd fragrant Body, without Addition of fire, degenerate into the rank Smell of Garlick.

A fragrant Body turnʼd into one of a Garlick Smell.

THE Odiferous Liquor mentioin'd in the preceding Experiment, being kept in a Bottle close stopp'd, in a little time acquir'd

a Garlick Smell. And the like Smell I have perceiv'd in an Oyl diſtill'd from vegetable and mineral Subſtances.

Salt of Tartar being digeſted with ſeveral times it's Quantity of Onions, acquir'd a Garlick Smell.

EXPEEIMENT X.

With an inodorous Body, and another not well ſcented, to produce a Musky Smell.

THIS we have done, by caſting ſmall Pearls into Spirit of Vitriol, for whilſt the *Menſtruum* was diſſolving them, we could evidently perceive a ſtrong Musky Smell. *A Perfume made of an inodorous, and another Body not well ſcented*

EXPERIMENT XI.

With fixed Metals, and Bodies either inodorous or ſtinking, to produce ſtrong and pleaſant Smells, like thoſe of ſome Vegetables and Minerals.

THO' Gold is inodorous, and *Aqua Regis* of an offenſive ſtrong Smell, yet the Solution being precipitated with Oyl of Tartar, and the Precipitate fulminated *per ſe* in a Silver Veſſel; we obſerv'd, that when the Fulmination was newly made, the Steams were of a very pleaſant Smell, like Musk; ſo that Art, by lucky Contextures, may imitate natural and ſpecifick Odours: And not only ſo, but Nature may endew ſeveral differing Bodies with ſimilar Smells; for in the *Weſt-Indies*, there is a ſort of Seed, which for it's Smell is term'd Musk-Seed; and in *To imitate vegetable Smells, &c.*

Muſcovy the Skins of *Musk-Rats*, have ſuch a kink of Smell; and Ducks at a certain Seaſon of the Year, if violently chaſed, emit a Musk Scent. And on the other hand, there is a certain Wood in the *East-Indies*, which ſmells like *Stercus Humanum*. And I remember, that having diſtill'd *Saccharum Saturni* with a ſtrong Fire, beſides the Empyreumatical Liquor, the *Caput mortuum* which was of a grayiſh Colour, emitted a pleaſant Scent. And we may obſerve, that Nature ſometimes takes the ſame way to produce different Effects; ſince tho' the Dung of moſt Animals is fætid, yet that of a Musk Animal is well ſcented. So that it is enough to introduce into a Body noble Qualities, that it hath a due Contexture and Conſtitution of Parts.

And on this Occaſion, I ſhall add, that the Excrements of other Animals are ſometimes ſo much vary'd by the Temper and Diſpoſitions of our Conſtitutions, that Dung hath at a certain diſtance, ſmell'd well, and like Musk to ſome People. And not to mention what hath been ſaid of *Alexander* the Great, I knew a Gentleman, whoſe Sweat was very fragrant. And Civet, which is ſo well ſcented, in a lax Air, is as offenſive to thoſe that come too near great Quantities. And it hath been obſerv'd, that a Monky upon eating Spiders, would cauſe a Scent like Musk.

EXPERIMENT XII.

To heighten good Smells by Compoſition.

To inrich Smells by Compoſition.

IT is obſerv'd, that a due Proportion of Civet or Musk mix'd with Amber-greaſe, promotes the Scent of it; for it is not the Quantity, but the Juſtneſs of Proportion that inriches the Scent. The beſt Proportion being 8 parts of Amber-greaſe, two of Musk, and one of Civet.

And it hath been obſerv'd, that Bodies inodorous mix'd with the Ingredients of Perfumes, promoted their Scent; for which End, Wine Vinegar hath been made uſe of by ſome.

And I my ſelf prepar'd an Eſſence of Musk, by digeſting ſome of it in Spirit of Wine for ſome Days, and then decanting the Tincture; and a weaker ſort may be made, by pouring Milk upon the remaing part of the Musk, and decanting it after a cold Digeſtion. And one thing in this Tincture obſervable, is, that tho' it, of it ſelf, hath but a weak Scent, yet if a few Drops of it be mix'd with good Sack, it perfumes the whole very richly, both in Smell and Taſte.

CHAP. III.

Many Changes of Colour produced by one simple Ingredient.

Several changes of Colour produced by one simple Ingredient.

TO make it appear how much the Colours of Bodies depend on the Variation of Texture, and their Modification, I try'd the following Experiments; in which several *Phænomena* are exhibited, by the Mixture of a colourless Ingredient, such as Spirit of Salt.

I. If a little Spirit of Salt be mix'd with Syrup of Violets upon a piece of Paper, it is presently turn'd from a Blew, to a red Colour inclining to a Purple.

II. But if Spirit of Salt be dropp'd in a just Proportion into a Solution of Filings of Copper, made with Spirit of *Sal Armoniack*, the Blew will be turn'd into a green Colour.

III. Having mixed Syrup of Violets with Spirit of Urine, Harts-horn or Oyl of Tartar *per Deliquium*, and by that means turn'd it green, I mix'd Spirit of Salt with it, which turn'd it red.

IV. If Spirit of Salt be dropp'd into Water, in which Red Rose Leaves well dry'd are put, it will make the Tincture to be of a lovely Red.

V.

V. But if Tincture of Braſil be heightned by an addition of Spirit of Hartshorn, or Urine, Spirit of Salt will make it as pale as Sack; ſo that that which heightenedthe Red Tincture in the former Experiment, deſtroys it in this.

VI. Tho an Infuſion of *Lignum Nephriticum* in Water, betwixt it and the Light appears yellow, yet when held ſo that the Eye may be placed betwixt it and the Window, it appears to be blew, yet upon the dropping of Spirit of Salt into it, it loſes that property.

VII. Having dropped Spirit of Salt upon Paper ſtained with Ink, the black was preſently changed into a yellow and blew colour.

VIII. If Filings of Steel be diſſolved in Spirit of Salt, the filtrated Liquor will, upon Evaporation, ſhoot into green Criſtals; which, if when they are dry they be kept in a Crucible, a moderate Heat will turn them red.

IX. We found that the red Precipitate of Mercury *per ſe* would diſſolve in Spirit of Salt, tho crude Mercury will not; we likewiſe found, that the Redneſs of *Minium* was wholly deſtroyed by boyling it in Spirit of Salt, and that the Tincture of Coral extracted with this Menſtruum, was wholly void of colour.

X. If Filings of Copper be long digeſted in a Sand-Furnace, in a good quantity of Spirit of Salt, *viz.* as much as will cover it the breadth of two Fingers, the Metal being in

part diſſolved, will be of a colour not unlike a muddy Red, if held betwixt your Eye and the the light.

XI. But if it ſtand ſome hours in a wide-mouthed glaſs, it will be of a green colour, finer than that which is made by a ſolution of *Mars*.

XII. If Spirit of Salt be dropped into a Solution of Silver, or Quicksilver in *Aqua Fortis*, the mixture will be of a milky whiteneſs, and preſently depoſite a white Precipitate.

XIII. And the ſame Phænomena will likewiſe happen, if Spirit of Salt be dropped upon a Tincture of *Benjamin*, or a Solution of *Reſinous Jalap*.

XIV. Having mixed a ſweet Solution of Red Lead in Spirit of Vinegar, with a Tincture of Red Roſes, I dropt Spirit of Salt into the mixture, which precipitated the red, and turned the green mixture into a durable Scarlet, which if diſturbed by a mixture of the white precipitate, will be of a Carnation colour.

XV. Spirit of Salt, which was muddy by ſtanding upon Filings of Copper, being boyl'd to a clearneſs, and ſet in a wide-mouth'd Criſtal Glaſs, in a ſmall time puts on the colour of a German Amethiſt; and, in three hours time, a lovely Green.

XVI. Having

XVI. Having gathered by filtration the Precipitate of Sublimate diſſolved in water, and when it was dry, poured Spirit of Salt upon it, in a glaſs Veſſel, the precipitate at the firſt will become white, and when the ebullition which ſucceeds the mixture is ended, it becomes a tranſparent Liquor.

XVII. Having dropt Spirit of Salt upon a fourth part of Calcined Copper, we found that the mixture produced a Tincture of a muddy Red, and a white Powder, which being acted on by the fire, exhibited ſeveral colours.

XVIII. The Solution of Copper, juſt now mention'd, being put into a Cylindrical Vial, and 2 or 3 Spoonfuls of highly rectify'd Spirit of Wine poured upon it, by ſhaking the mixture we obtained a Liquor of a green Colour like that of Emeralds.

XIX. A few drops of Spirit of Wine being dropt upon a Taffety Ribband, chang'd its Green into a Blew Colour; and being dropt on a black Ribband, alter'd that, and made it put on that which is call'd a Fading Leaf.

XX. If Spirit of Salt be dropt upon Purple Paper, it preſently turns it Red.

XXI. Powder of Antimony being boyl'd to a Diſſolution in Spirit of Salt, in a glaſs Veſſel, loſt its blackneſs, and the Solution being dropt into Water, it in a little time ſubſided in the Form of a white Precipitate.

These Experiments being laid down, it may be necessary for us to observe, how unexpected the Result of most Mixtures are; which may be an Argument against the too frequent use of Compound Prescriptions, since it often not only is uncertain how those Ingredients may destroy the Vertues of each other, but sometimes whether they will duly mix according to Physitians expectation.

CHAP. IV.

An Experimental History of COLOURS *begun.*

Containing Part the First.

Diversity of Colour not always an Argument of a variety in Qualities.

THO there are some, especially Chymists, who think that a considerable Diversity of Colours, must always imploy a Diversity of Nature; yet we see, that Taffaties are endued with changable Colours, as well as the Feathers of several Birds, which have as great an Affinity in Nature as in Place; and not only several Feathers vary in Colour from one another, but sometimes several parts of the same Feather: And there is no less variety of Colour in several Leaves of Flowers, tho no difference can be discovered in their Properties: A considerable Instance in which, we have in *Marvail* of *Peru*, which tho it produces several Scores of Flowers in its Season, yet I have scarce found two coloured alike.

But

But tho I believe that a variety of Colours does not always imply a Diversity of Properties, yet I question not, but that an alteration, in point of Colour, signifies a Variation in the Disposition of Parts of Bodies; which is evident in the Extraction of Tinctures, and several other Chymical Operations, wherein the Change of Colours is the only Observation by which the Artist regulates his Process. So we see, that several Degrees of Maturation produces various Colours in Fruit; and Steel, if it be heated glowing hot in the fire, and held over a Bason of Water, till it changes its white to a red Colour, so far as is then quench'd will be hard'ned, and when polish'd at the end, will look whitish; but if the end of the Steel be held in a Candle, so that the polish'd part may not be sully'd, that which is almost contiguous to the Candle, would change from a bright Yellow to a deep one, or a sanguine Blew, and from that to a fainter, and then to a deeper Blew; and in each of these different Appearances, its Texture is so much different, that if whilst it is yellow it be cooled, it is fit for Gravers Drills, but when blew, it is softer and fit for Springs of Watches; and if it be kept long in the flame after this blew appears, it will be too soft for Drills till hardned again. And it is not a little pleasant to see how these Colours will succeed one another and run along the Steel very fast. But because the flame of a Candle usually sullies the Steel, we generally make use of a red-hot Iron to heat it with.

The changes of Colour oft signify Alteration in the Properties of Bodies.

But not to prosecute these Experiments out of their due Place, before I descend more Particularly

What is meant by Colour.

ticularly to present you with my Considerations concerning Colours, I think it requisite to premise, That Colour being a Word of a twofold Signification, in the following Discourse, I shall sometimes use it to signifie only the Sensation of those reflected and modified Rays of Light, which cause that Effect on the Sensory; and generally, in the vulgar Acceptation, intimating by it, the Disposition in the Object which causes the Rays of Light to be reflected, so as to produce on the Sensory this or that Colour.

What the Perception of Colours depends upon.

And, perhaps, it may not be inconvenient to add, that it is the Opinion of several Modern Atomists, that the Sensation of Colours depends not so much on the inherent Qualities of the Object in the Sense, but that such a Motion is given to the Spirits in the *Retina*, that that communicated to the Brain, and causing a Local Motion in some part of it, we always think we see such a colour, when the slender strings of the *Retina* are put into a like Motion, whether the Light concurs to the Production of that Motion or not; whence dreaming Men often think they see several things in their sleep; and distracted Persons fancy they see several things before them, which depends only upon an Internal Local Motion of their Spirits: And so upon a violent blow upon the Eye, we sometimes fancy we see Lightning and flashes of Fire; and even upon a blow on the Head, or when internal Humours cause such a Concussion in the extremities of the Optick Nerves, as is wont to produce a Sensation of Light. And I remember, that having my self a violent Cough,

Cough, I fancy'd I saw flashes of Light, which presently disappear'd again: and a very discreet Lady observ'd, that the day before she was seiz'd with some violent Hysterick and Hypochondriacal Fits, which for the time gave her a tastard Palsey, every thing before her seem'd to be dyed with bright and vivid, but unusual colours: And I am told by an ingenious Gentleman, that several that were seiz'd with the Plague, sometime before, fancy'd every thing coloured over very beautifully; and this Symptom was successfully remov'd, as well as the other Symptoms of that Distemper by a Vomit. The Vomit which was successfully given in this was made of about 8 or 10 Drachms of *Crocus Metallorum*, and half a Drachm of white Vitriol.

But further, as the Apparition of a Colour may be caus'd by the Motion of the Humors within, so the Sensory being Indispos'd, that indisposition may vary the appearance of External Objects: For I have taken notice, that after looking upon the Sun or Moon with a Telescope, my Eye hath been so alter'd, that the flame of a Candle seem'd to vary much in its colour from what it used to be, and if I often open'd and shut my Eye whilst that adventitious Colour seem'd to last, I could discern it gradually diminish, till the Candle appear'd to me as before; and one thing worthy of notice was, that if I looked upon the Object with one Eye, when the dazled Eye was shut, the Adventitious Colour disappear'd, but was visible again upon opening the dazled Eye.

To

To this Observation I shall add, that a Lady, who had by a Fall, got a Hurt near her Eye, for six Weeks together fancy'd every thing cover'd over with very dazling and glorious Colours, especially white Bodies, some of which were such as she could not describe. And a Learned Gentleman told me, that looking upon the Sun with a good Telescope, without a colour'd Glass to guard his Sight, the Brightness of the Object left such an Indisposition in his Eye, that nine or ten Years after, whenever he look'd upon the Window, he fancy'd he saw a light Body before his Eye, of the Size and Brightness of the Sun, as it appear'd to him in the Telescope; to which Instances, I could add others from the Experienc'd *Epiphanius Ferdinandus*, of the Symptoms of those Bitten by a *Tarantula*; from whence it would appear, that an Indisposition in the Organ of Vision, is sufficient to vary our Judgment of Colours, but these may be more properly deliver'd in another place.

The Superficies of a Body consider'd as the cause of Colours.

But to proceed, from what hath been said it appears, I allow and teach, that the superficial Parts of a Body, reflecting the Rays of Light, and modifying them, may in one sense be said to be the Cause of that Colour it represents, since as the Beams of Light are variously modify'd, we perceive several Sensations.

And tho' some hold, that the Rays of Light which convey th Colours, are not reflected barely from the Superficies of a Body, but penetrate deeper into it's Substance; yet we are apt to call those Bodies transparent or semidiaphonous, whose Substance the Rays of Light visibly insinuate

themselves into: And that in all Bodies there is such Penetration of Light is evident, since several Substances appear to be of one Colour on the outside, and of another within; which is evident not only in Fruit, but temper'd Steel; for tho' it be furnish'd with very vivid Colours on the Superficies, yet within a Hairs breadth of it, it retains it's Steel Colour: And a more eminent Instance is, that Lead being melted and pour'd into an Iron Vessel, when the Scum was taken off, several Colours succeeded one another, upon it's Superficies, and that which appear'd last, before the Metal cool'd, remaining upon the Superficies of it, we found, that if never so little was taken off, that adventitious Colour would be taken off too, and the Metal would appear in it's own Colour; which shews not only what I alledg'd it for; but also, that probably an adventitious Colour may be acquir'd by the Effects the saline Parts of the Air, have on Lead so dispos'd to receive it's Impressions, which it will not do, till brought to a much higher degree of Fusion than bare melting. One thing remarkable in these Colours was, that they succeed not so regularly as those in Steel, but in the following order,

Viz. Blew, Yellow, Purple, Blew; Green, Purple Blew, Yellow, Red; Purple, Blew, Yellow and Blew; Yellow, Blew, Purple, Green mixt, Yellow; Red, Blew, Green, Yellow, Red, Purple, Green.

Tho' it is held by antient Atomists, that the Figure of a Body is sufficient to vary it's Colour; yet

yet I am perſwaded, that there are other things requiſite; ſince we ſee by the help of good Teleſcopes, that the Superficies of Bodies are not only full of ſeveral Protuberances, but likewiſe ſeveral Cavities, which appear not to the naked Eye; ſo that the very Figures of thoſe may have a great ſtroke in cauſing various Colours, and differently forming the Superficies of a Body, ſo as to enable it variouſly to reflect the Rays of Light, and cauſe different Effects in our Organ of Senſe.

The various Figures of the Superficial Parts requiſite for the Production of Colours.

But beſides the various Figures of theſe ſuperficial Particles, the Surface of a Body may be enabled variouſly to reflect the Rays of Light, as they are bigger or leſs; and the Protuberant Particles are ſet cloſer, or at a greater diſtance: So Water if it have but a few Bubbles on the Top of it, hath ſcarce any ſenſible Colour, but if it be beaten into a Froth, and a great number of Bubbles are cloſe ſet, it preſently varies it's Colour, and ſeems white; to which not only the Number, but the Convex Superficies of the Bubbles conduce; nor is it requiſite, that all the Protuberant Corpuſcles ſhould be of one Figure, ſince, thoſe which produce a Blew, and thoſe that yield a Yellow being mix'd together, afford a green Colour. But further, the Cavities intercepted betwixt the Protuberant Parts and their Figures, are to be conſider'd in the Production of Colours, as well as the Figure and Size of the Particles themſelves: For the Superficies of a Body may be cut tranſverſly with a Methamatical Plain, void of Depth or Thickneſs, above which as well as below, may be ſeveral Superficies, as in the Superficies of the Earth, there may be ſeveral Parts a-

bove

bove the Horizontal Plain as well as below; upon which Account, the Rays of Light may be ſo differently reflected, as to cauſe different Colours; ſo the two ſides of a Piece of red Glaſs ſeem differently colour'd, when the one is Rough, and the other Poliſh'd; and tho' ſeveral ſorts of Marbles are never ſo curiouſly poliſh'd, yet their Superficies ſo far vary, as to exhibit diſtinct Colours.

The Situation of them likewiſe requiſite.

Beſides, in variouſly reflecting the Rays of Light, the Situation of the ſuperficial Parts of a Body are conſiderable, in reference to the Light and the Poſition of the Eye, and alſo their order in reference to each other; for the Rays of Light will be differently reflected to the Eye, from Parts which are erected upon a ſuperficial Plain, from what it will be from thoſe Parts inclined and obverted to the Eye; ſo Plush or Velvet varies it's Colour as the Parts of it are differently inclin'd; and a Field of Corn varies it's Colour as the Wind depreſſes the Ears of Corn ſucceſſively, or in different places: And for a like Reaſon the Hair of a Dog exhibits a different Colour, when the order of them is changed; and ſo the Parts of Water in Froth, and the Parts of Harts-horn ſhaved, alter their Colours, and Glaſs by being beaten, loſes it's Tranſparency with the order of it's Parts, and becomes white; And for a Reaſon not very different, I have obſerved, that Peaſe ſet in parallel Lines, when they are riſen about half a quarter above the Ground, by caſting one Eye the ſame way with the parallel Lines, the Ground would appear of it's own dirty Colour, but if I look'd upon it tranſverſly, it would wholly appear green,

green, the Rays which were reflected from the Soil being intercepted.

The Motion of the parts of a Body contribute to the Colour.

And that the motion of the Parts of a Liquor, may contribute to the change of a Colour, I am perſwaded, ſince I have elſewhere mention'd a Liquor, which, whilſt it was at reſt, would be clear and tranſparent, but when it's Parts were put into Motion, they would riſe up and form a white Fume; and the like Fumes I have obſerv'd to riſe from a Liquor diaphanous, and another red. And if the Superficies of a Body be made up of Parts, whoſe different ſides afford ſeveral Colours, then the Motion or Reſt of that Body may contribute to the variation or continuance of a Colour, ſince a new ſide being turn'd towards the Eye, we muſt conſequently ſee a new Colour; ſo when the Leaves of a Tree, whoſe Colour on each ſide varies, are forced by the Wind, to appear with their other ſides outward, they exhibit a new Colour, tho' a few of them makes no conſiderable Alteration; as a ſingle Thred of Scarlet, ſeems almoſt void of Redneſs; but when ſeveral of them are placed together, their Colour becomes more conſpicuous. So likewiſe in a Piece of Taffety which is made of red and blew Threds interwoven, I found by a Microſcope, that when the Silk was ſo commodiouſly placed, that the blew Threds were not intercepted by the red ones, the Colour would be blew; but when the red Threds were more commodiouſly placed than the others, the Colour would vary: Wherefore it would not be amiſs to endeavour to diſcover a Reaſon, by the Uſe of Microſcopes, why Mother of Pearl, Opals and ſuch like Bodies

dies are of ſuch curious Colours, and what contexture of Parts is apt to produce Colours ſo delightful.

But till we are furniſh'd with better Microſcopes, or more exquiſite Senſes, I fear theſe things muſt be undiſcover'd, ſince there are ſeveral degrees of Aſperity, and the Parts which form them are ſo minute, that we are not able to know how their Shades are mix'd with, or intercepted one by another; tho' I was told by Dr. *Finch*, that there was a Blind Man at *Maſtricht*, not far from *Utrecht*, who was able to diſtinguiſh ſimple Colours by the Touch, tho' mix'd Colours he could not diſcern: And *How far Aſperity contributes to Colours.*

The Account this Man gave the Doctor of his Senſations of thoſe Colours was, that Black and White were the moſt Aſperous Colours, and ſo like, that it was hard to diſtinguiſh them; but Black was the rougher of the two; Green next to it, Gray next to Green, Yellow a degree below that, Red and Blew ſo much alike, that they were hard to be diſtinguiſh'd, but that Blew was the leaſt rough of the two; and theſe Diverſities of Surfaces this Man diſcover'd, by placing the Body whoſe Colours he was to try betwixt his Thumb and his Fore-finger; And it was very remarkable, that his Thumb was not only the moſt ſenſible of the two, but that he had only this Exquiſiteneſs of Senſe when faſting, the leaſt drink diſabling him, to diſtinguiſh ſo nicely the difference of Colours.

But I am apt to ſuſpect, that this blind Man rather diſcriminated theſe different Colours by the Smell of the ingredients, than the Touch; and that if the Organ of Touch contributed to

it, it rather did it, by diſcovering the ſeveral *Forms* than *Degrees* of Aſperity, ſince he found it ſo difficult to diſtinguiſh Black and White from one another, tho' not from other Colours; and indeed tho' the Ribbons which were offer'd might be almoſt equally rough, yet in ſuch ſlender Corpuſcles as thoſe which reflect the Rays of Light, we may eaſily conceive, not only a greater cloſeneſs of Parts, or a paucity of extant Parts, but that they may be otherwiſe ranged, and the Cavities left betwixt, much deeper in one than the other; for ſuppoſing the Protuberant Particles to be very ſlender, and cylindrical like the Hair of a Bruſh, and furniſh'd with Hemiſpherical Tops, they may be ſo very ſharp, that a leſs exquiſite Touch, cannot diſtinguiſh them, than that of this blind Man. Nor is every kind of Roughneſs inconſiſtent with Whiteneſs ſince the level Superficies of Water being made rough by Bubbles, preſently acquires a Whiteneſs, and ſo does Glaſs when ſcratch'd with a Diamond.

But to proceed, ſuppoſing the ſharp pointed Particles which are ranged upon the Superficies of black and white Bodies were ſo like, that the Touch could not diſtinguiſh them eaſily; yet upon the Account of ſome difference in the Cavities, which intercept the Rays of Light, they may variouſly reflect it; as if the Cavities of a black Body be deep, and the other ſuperficial, the one will drown and detain the Rays of Light, whilſt the others undiſturbedly reflect them. From whence it appears, that Colours rather depend on different Forms of Aſperities, than on different degrees of it; and tho' the

the blind Man tells us, that Black was the roughest of Colours, yet it does not therefore follow, that those Bodies which have the least Asperities, must be the lightest, and reflect the Rays of Light most, since according to him, White is the roughest next to Black; and tho' he assigns Yellow two degrees less of Asperity than Green, and as many more than Blew, yet it is manifestly to the Eye a lighter Colour, and reflects the Rays of Light more plentifully than either.

How many ways Liquors may alter Colours.

But to return to what I was saying of the different Asperities of Bodies, by which Colours may be diversify'd: To assist us to judge of the Reason of the Changes in Colours produc'd by corrosive saline Corpuscles in a fluid Form, I shall consider how many ways such Liquors may, by working upon them, alter the Superficies of Bodies upon which they act, and consequently cause them variously to reflect the Rays of Light.

And *First*, Such Liquors may alter the Colours of Bodies, by insinuating and lodging their small Particles in the Pores of a Body: So Oyl or Water dropp'd upon Paper, alters the Colour of it; and the High Road upon Rain loses it's dry Colour, and changes it for another.

Secondly, A Liquor may alter the Colour of a Body, by freeing it from an adventitious Colour; as when the dirty Colour of Gold is taken off by putting it into the fire or *Aq. Fortis*. And not only Silver may be restored by the like means to it's genuine Lustre, but I know a volatile Liquor, which, incorporating with Grease, will take such Stains out of Cloaths. And I have try'd, that having rubb'd a Compound Metalline Body

on a Touch-ſtone, *Aq. Fortis* would take off all the other Ingredients, and leave the Gold, appearing with its genuine Colour.

Thirdly, A Liquor may alter the Colour of a Body, either by deſtroying or ſubdividing the Parts of it; as when Wood is cut into Chips, or a piece of hot Cryſtal quench'd in cold Water, for it being by that means crack'd, will not reflect the Rays of Light as before.

Fourthly, A Liquor may change the Colour of another Body, by collecting together Parts of Matter ſcatter'd and diſpers'd; ſo Quick-ſilver pour'd into a Solution of Gold, acquires a thin Film, of a yellow golden Colour; and by a like Method all thoſe Colours, that ſeem to be produc'd by Precipitation, are generated; tho' Reſinous Gums diſſolv'd in Spirit of Wine being unites into a Maſs again; and ſo rectify'd tranſparent Butter of Antimony, upon a Mixture of Water precipitates that white Subſtance, which when it's Salts are waſh'd off, is called *Mercurius Vitæ*.

A Fifth way, by which a Liquor may alter the Colour of another Body, is, by altering the Texture of it's Parts, as, when Quickſilver is kept long in a convenient Heat; Metals are corroded, or Fruit is bruiſed; or when the Parts of a Liquor are agitated by the Affuſion of another Body; or when Chymical Oyls are ſhaken in a Bottle; for the Bubbles by that means rais'd will exhibit very lively Colours.

Another way, is, by putting the Parts of a Body into Motion, after which they may unite in a new Form; ſo Vitriol rubb'd upon the Blade of a Knife, imparts not any new Colour to it; but

but if the Vitriol be moiſten'd, it will impart a true Copper Colour to the Iron.

Another way by which a new Colour may be imparted to a Liquor, is, by an Aſſociation of it's ſaline Parts with thoſe of the Body it is made uſe of to work upon, by which means the ſuperficial Parts of a Body, may be alter'd both in Shape and Figure; and not only a greater number or a leſs, may be compriz'd in the ſame ſpace, but the Pores betwixt the Protuberant Parts may be much ſtraitned, and the old ones partly fill'd up, as well as new ones intercepted; as when Quickſilver is diſſolv'd in *Aq. Fortis*, the ſaline Parts of the *Menſtruum* aſſociating themſelves with the Mercurial Corpuſcles, will afford a Green, which afterwards degenerates eaſily. And ſo *Minium* by being diſſolv'd in Spirit of Vinegar, yields a clear Solution; and if *Aqua Fortis* be dropp'd upon a Copper Plate, the Parts of the Metal being corroded, acquire an Aſperity, and coagulating with the *Menſtruum* form Grains of blew Vitriol, whereas Spirit of Urine will produce a much deeper Blew. And *Aqua Fortis*, which will give Red Lead a dark Colour, with crude Lead will produce a white one, with Iron, a reddiſh, and upon white Quills a yellowiſh Colour. And that in Chymical Diſſolutions and Precipitations the ſaline Parts of the Body made uſe of to precipitate, unite with metalline Parts they precipitate, we ſhall have reaſon to believe if we conſider how much Vitriol, and the *Calces* of Metals are heavier than the Metals themſelves.

After what we have laid down concerning the Cauſes of Changes of Colours, there are

two things to be taken Notice of; The one is, that there are other ways to vary Colours ſpeedily, beſides thoſe we have taken notice of by the help of Liquors; as in Trmpering Steel, &c. The ſecond Particular requiſite to be noted is, that tho' a Change of Colour may be effected any one of the ways above-mention'd, yet generally at leaſt three of them are at once concerned.

Several Bodies generally eſteemed opacous ſemidiaphanous.

From what we have been diſcourſing of the Aſperities of Bodies in cauſing a Reflection of the Rays of Light, one would think that the Subſtances themſelves are perfectly opacous and impenetrable by the Rays of Light, and ſo contribute to the Variety of Colours, reflected to the Eye: But I am apt to believe, that even thoſe Bodies which we call Inſenſible, are compounded of Parts ſtill more minute, whoſe Commiſſures are not utterly impervious to the Rays of Light, and that the Bodies compounded of thoſe are in ſome degree Diaphanous. For in a dark Room, where the Light is only permitted to enter at one Hole, I have obſerv'd, that thoſe Motes which were otherwiſe inſenſible; in the Beams of Light, would repreſent ſeveral vivid and florid Colours, like thoſe of a Rainbow, or of ſparkling Fragments of Diamonds; and as ſoon as that Poſition, which they had at that time, in reference to the Eye and the Light, was loſt, they ceas'd to repreſent thoſe Colours, tho' ſtill remain'd viſible; ſo that from hence it appear'd, that theſe ſmall Fragments of Matter, commonly reputed Opacous, did not barely reflect, but alſo refracted the Rays of Light: And it is not a *Phænomenon* alto-

altogether to be ſlighted, that Water, tho' a diaphanous Body, hath a manifeſt Power in refracting the Rays of Light ſo, that by paſſing through it, they repreſent the lively Colours of a Rainbow.

And it is further obſervable, that ſeveral Bodies which are generally eſteem'd Opacous, appear in a great meaſure tranſparent, when they are reduc'd into thin Parts, and interpos'd betwixt the Eye and a Powerful Light, which is evident in thin Plates of Ivory, thick Leaves of Trees, Shells of Fiſhes and ſhavings of Wood. And in a darkned Room I found, that the Subſtance of my Hand was in a great meaſure tranſparent, when it was held betwixt my Eyes and the Rays of Light which came in at a ſmall Hole.

And not only white Marble of a convenient Thickneſs, but *Lapis Specularis*, or Muſcovite Glaſs, being divided into thin Plates, will be conſiderably tranſparent; and even Coral it ſelf will manifeſt the ſame Tranſparency if held near the Light.

But on the other hand, I muſt own, that having look'd upon Mercury precipitate *per ſe*, Filings of Copper and Steel, the Red *Calx* of Lead, and the Red Colour of Vitriol, they appear'd not to have the leaſt Tranſparency.

How far the Tranſparency or Semidiaphaneity of Bodies may contribute to the Variety of Colours produc'd by them, I ſhall not take upon me to determine, ſince beaten Glaſs, Snow and Ice, whoſe ſuperficial Parts are manifeſtly tranſparent, repreſent not the lively Colours

which they do when conveniently qualifi'd by their Bigneſs, Shape and Texture.

But to draw an Inference from what hath been ſaid of the Cauſe of Colours; It appears, that according to the *Hypotheſis* we have laid down, Bodies can only be ſaid to be coloured when placed in the Light; but that, according to the Antients, if we take the Senſe of the Word Colour, to mean only that Diſpoſition of the ſuperficial Surface of a Body, which enables it to modifie the Rays of Light; They may be ſaid to have Colours in the Dark, ſince they have that Diſpoſition, which enables them to reflect the Rays of Light in ſuch a Form as to produce Colours.

Tot ſhort duration of Colours no Argument of their not being genuine.

And from what hath been deliver'd, it likewiſe appears, that tho' Colours which are evanid, and laſt but for a while, as the Colours of the Rain-bow, and all Emphatical Colours, are generally diſtinguiſh'd from True and Genuine ones, in as much as the latter are produc'd by Reflection, and theſe proceed from Refraction; yet, ſince we uſually account all Eccboes genuine Sounds, and all Smells true Smells, in as much as they are real Objects of the reſpective Senſories they affect, by the ſame Reaſon we may conclude theſe Emphatical Colours genuine, ſince the Rays of Light equally affect our Senſory for the time: And tho' the ſhortneſs of their Continuance hath been offer'd as an Argument of their not being genuine, by the ſame Rule we might ſay, that the Colour of Graſs is not genuine, becauſe the Colour of an Emerald is more laſting; but white Colour of Froth is held to be genuine, tho' it is

ſoon

tion generated, and in a little time deſtroy'd. Beſides, were the Whiteneſs of Froth accounted an imaginary Colour, we muſt no longer believe ſuch to be diſtinguiſh'd from genuine ones, by Refraction; ſince Froth retains it's Whiteneſs, whether the Sun be ſetting, riſing, or at the Meridian; the Poſition of the Sun in reference to the Eye, and the Object not at all diverſifying it.

Moreover, were a Colour to be pronounced genuine by the time of it's Duration, the white Froth of a Tenacious Body, might be ſaid to be more genuine, becauſe it will continue much longer, than the Colour of thoſe Flowers of the *Mervail of Peru*, which fade the very day they are Blown: And I have ſeen a *Virginian* Flower, which ſeldom continues longer than a day.

And that the bare Diſpoſition of the Parts of a Body, by which it is ſaid to reflect or refract the Rays of Light is ſufficient to produce different Colours, is not only evident in Cloth held in ſeveral Poſitions, by which means it variouſly reflects the Rays of Light; but it is further evident, ſince the Beams of the Sun trajected through a Priſmatical Glaſs, repreſent a lively and vivid Rain-bow, upon any Body upon which they terminate, which may be diſcern'd by the Eye, plac'd in any Poſition whatſoever, *viz.* whether above, or below, or on the ſide of the Glaſs. And tho' when the Priſm is taken away, the Rain-bow diſappears, yet nevertheleſs, the Light, for the time being truly reflected and refracted from the Priſm, and reflected again from the Body, which thoſe Parts

Parts of Matter light on, repreſent as genuine a Colour to the Eye, as that of any other Body; ſo the Colours of external Objects repreſented upon a Wall in a dark Room, are truly the Colours of thoſe Bodies, tho' the reflected Rays leave no Traces of themſelves on the Wall they are reflected from; and tho' we may conclude, that the Colour reflected from the Wall is it's own, and not communicated by external Objects, yet it is no Error of the Eye which receives external Objects, but of the Judgment, and Eſtimative Faculty, ſince we ſee that the Rays reflected from the Wall falls upon our Eye in a direct Line: And for a like Reaſon we are apt to think, that the Image of a Body, caſt up into the Air by a Concave Spherical Glaſs comes forth to meet us, and hangs in the Air betwixt the Glaſs and us; becauſe the reflected Beams croſſing in that Place, are from thence reflected in direct Lines to the Eye, and not from the Glaſs: And there is one thing I ſhall here add to the Doctrine of Colours, which is, that even thoſe Colours which are accounted Imaginary, becauſe not inherent in the Bodies in which they appear, may be compounded as well with one another as thoſe that are genuine.

Several Opinions of the cauſes of Colours.

To conclude this Chapter, I ſhall briefly intimate, that there are ſeveral Opinions at this time, beſides thoſe already rejected, which have Eminent Men for their Abettors; as that of the Peripateticks, who teach that Colours are real inherent Qualities, which the Light does not concur to produce, but barely diſcloſe. Other Moderns hold, that Colours depend not merely

merely on the Lucid Parts of an Object darted to the Eye, according to *Plato*, but that they are vary'd and alter'd by the Mixture of leſs luminous Parts: By others it is Taught, that Colours proceed from a Lucid Steam or *Effluvia* paſſing from the Object to the Eye; which, as ſome teach, are excited by the Influence of external Light. And there is another Set of Philoſophers who teach, that Colours proceed from a Mixture of Light and Darkneſs, or rather Light and Shadows. As for the Chymiſts, the Generality of them aſcribe the Origin of Colours to the *Sulphureous Principles* of Bodies, ſome of them to *Salt*, and others to *Mercury*. But the *Carteſians* ſuppoſe only, a Senſation of Light to proceed from an Impulſe of very minute and ſolid Globules, to which, the Pores of the Air and other diaphanous Bodies are pervious; and as the progreſſive Motion of theſe Globules are different, ſo they variouſly affect the Senſory, and Cauſe a Senſation of different Colours.

But not to ſpend ſo much time as it would require to examine theſe ſeveral Opinions, I ſhall only briefly intimate, that I think it queſtionable whether any of theſe *Hypotheſes* have a Right to be receiv'd more than another; ſince I queſtion not, but I ſhall make it appear, that Whiteneſs and Blackneſs may be produc'd by a bare Reflection; and tho' by a Mixture of true White and Black, no other Colour will be produc'd, yet, theſe Colours may be produc'd by Refraction in a Glaſs Priſm; and as I believe, that if we were ſure, that the Pores of the Air and other Bodies were fill'd with ſuch *Globuli*

as

as the *Carteſians* ſuppoſe, the ſeveral kinds of Motions of theſe *Globuli* might contribute to vary the Perception of Colours, ſo I think that without ſuch *Globuli*, the Rays of Light may variouſly affect the Eye themſelves, as their Motion is vary'd in order, or degrees of Swiftneſs when they affect our Senſory, or as their Motion is undulating or more or leſs direct.

But ſince I pretend not this Diſcourſe to be a compleat Hiſtory of Colours, I ſhall only in their proper Place deliver ſome Experiments, which may ſhew the Inſufficiency of the Peripateticks and the Doctrine of the Chymiſts, and in favour of that opinion which I am moſt inclin'd to be of; which is, that Colour is a Modification of the Beams of Light, which they receive from the Object, from whence being reflected to the Eye, they cauſe that Senſation we call Colour. But how they come to be ſo modify'd, I ſhall not take upon me to declare, till I know both what Light is it ſelf, and what figur'd Corpuſcles it conſiſts of, and likewiſe their Size and Motion: And before I pretend to lay down my Opinion, I would further be ſatisfy'd what is the Nature of Refraction, and what degrees of Commixture of Shades with the Light, made in the ſuperficial Parts of a Body is requiſite to produce this or that Colour.

CHAP.

CHAP. V.

Of the Nature of Whiteneſs and Blackneſs. Part. II. *Of the Experimental Hiſtory of Colours.*

ACcording to *Ariſtotle* it is taught by *Democritus*, that Blackneſs depends on the Aſperity of the Surface of a Body; and *Gaſſendus*, who is the firſt that hath attempted to explain the contrary Colour, *viz.* Whiteneſs, mechanically gives us the following Account; *Cogites velim* (ſays he) *lucem quidem in Diaphano nullius coloris videri, ſed in opaco terminante candicare, ac tanto magis, quanto denſior ſeu collectior fuerit. Deinde Aquam non eſſe quidem coloris ex ſe candidi, & radium tamen ex eo reflexum verſus Oculum candicare. Rurſus eum plana Aquæ Superficies, non niſi ex una parte eam Reflectionem faciat: Si contigerit tamen illam in aliquot Bullas intumeſcere, Bullam unamquamq; reflectionem facere, & candoris ſpeciem creare, certa ſuperficiei parte. Ad hæc ſpumam ex Aqua pura, non alia ratione, videri candeſcere & albeſcere, quam quod ſit congeries confertiſſima minutiſſimarum Bullarum, quarum unaquaque ſuum radium reflectit, unde continens candor alborve apparet. Denique nivem nihil aliud videri quam ſpeciem puriſſimæ ſpumæ ex bullulis quam minutiſſimis & confertiſſimis cohærentis. Sed ridiculum exhibeam, ſi tales meas Nugas uberius proponem.* A mechanical account of Whiteneſs.

But tho' this Account be ingenious enough, yet I ſhall to render it more full: Add, that White-

Whiteneſs conſider'd as a Quality in the Object, depends on the Aſperity of the Surface of a Body, whoſe Parts are ſo ranged as to reflect the Rays of Light, not upon one another, but upon the Spectators Eye, and that too, barely by reflecting them as a Looking-glaſs does, without Refraction; for in moſt other Colours they are ſo ranged, as either to alter the Texture of the reflected Light, or to vary it with Shades; but in reflecting the Rays of Light to repreſent the Body white, it is not only requiſite, that the reflected Beams ſhould be unalter'd, but likewiſe, that they ſhould almoſt all be reflected back, ſo that ſome of them facing one way, and ſome another, they may obvert themſelves to the Eye on which ſide ſoever it is placed.

To illuſtrate this Opinion with Experiments and Obſervations, I ſhall firſt obſerve, that the Colour of the Sun at Mid-day in clear Weather, is much more near to a Whiteneſs, than when ſtain'd by ſublunary Bodies, and than when near the Horizon, where it's Rays have a greater Quantity of Atmoſpherical Parts of Matter to paſs through; and Water it ſelf the more it is ſhin'd on appears to be much whiter to the Spectators: And I have taken notice, that the Sun when cover'd with a white Cloud, hath appear'd in the Water to be not red, but white: And it is obſerv'd by Smiths, that Iron, which when moderately hot appears red, when it hath acquir'd a higher degree of Ignition, it ſeems to be white.

So thoſe that have weak Eyes complain of too great a Reflection of Light, when the Ground is cover'd with Snow; and it is atteſted by ſeveral

ral Writers and other Travellers, that the Whiteneſs of the Sun hath been ſo great, that in *Muſcovy* and *Ruſſia* they found the Snow, to reflect the Light ſo much, that they could ſee much farther upon ſnowy Ground, than we here in *England*, where no Snow lies on the Ground; ſo that they could ſee their way by the bare Reflection of the Snow, when the Sun did not ſhine. Tho' I am apt to believe, that the Effect might in ſome meaſure proceed from the Clearneſs of the Air, cleans'd of thoſe Steams which ſometimes darken it; ſince it appears, that we are able in a froſty Night by reaſon of the clearneſs of the Air, to diſcern more Stars than at other times.

And that white Bodies reflect the Rays of Light moſt plentifully, and have no native Light of their own appears, ſince Snow encloſed in a dark Room was not at all viſible: But on the contrary it is obſerv'd, that white Cloths are the moſt eaſily diſcerned in dark Nights.

And for a further Confirmation that white Bodies reflect the Rays of Light not only moſt plentifully, but from themſelves; I ſhall add, that if the Rays of Light, which enter into a dark Room at a ſmall Hole, Light upon a white Wall, they Enlighten the Room much further than if they fall upon any other Colour. And that white Bodies caſt moſt Rays of Light from themſelves appears, ſince, white Paper is not near ſo apt to be ſet on fire by a Burning-Glaſs as black, the concentred Beams being reflected back much more by the one than the other. To which I ſhall further add, that,

I have

I have perceiv'd a much greater degree of Heat, when I have held my Hand in the Sun Beams, with a black Glove on; than when it was covered with a White one.

And to shew that white Bodies not only reflect the Rays of Light plentifully, but unstain'd, I shall add, that in a dark Room, when the Rays reflected from a coloured Body, were thrown upon a white Wall, they would represent the Colour of that Body, whereas, if the Beams Reflected from a yellow Body upon a blew, it would make a green.

And to these I shall further add, on this occasion, that having cast the Rays of a troubled Water, by the help of a Lenticular Glass, into an upper Room darkened, the concenter'd Reflections of the glittering Waves at a few Paces distance, represented a white Body; but if we approached near the Place on which those Rays were cast, they only seem'd to be Beams reflected from glittering Waves, which appear'd like so many shining Scales of Fishes, succeeding each other successively and disappearing again. But if the seeming Whiteness of a River, proceed not from the reflection of the Sun Beams, but the brightness of the Sky, a Storm may cause the Surface of it to appear Black, the Rays of Light, being reflected more inward than outward; except near the Sea Shore, where the Surface of the agitated Water is covered with Froth.

The Surfaces of White Bodies Specular.

But to shew, that the Surfaces of white Bodies are Specular, I shall Subjoyn, that drops of Mercury being rais'd, by a convenient heat in an Alembick, represented so many looking Glasses,

Glaſſes, but cauſed the ſides of the Glaſs they ſtuck to, to appear White: And it's obſerv'd, that if we look upon the Milky Way or Galaxy, with a Teleſcope, tho' to our Eye it appears White, by the help of that we ſhall diſcover, that that Whitneſs only depended upon a Collection of the Rays of Light, whoſe confuſed Beams repreſented to the Eye, a white Body; and why for a like Reaſon, the Superficies of a Body, which to the Eye reflects the Beams confuſedly may not appear White, as well as the Planets which ſhine by a borrow'd Light, I ſee no contradictory Reaſon.

But to return to Experiments, we ſee, that the whites of Eggs, which are in ſome meaſure Natural Speculums, by being beaten into a Froth appear White. And if Oyl of Turpentine be mixed with Water, and ſhaken in a Vial, as the Particles of the Oyl are more or leſs numerous, and minutely divided, it appears more or leſs White; which Experiment will likewiſe ſucceed if tryed with a yellow Mixture of crude Turpentine, inſtead of the Oyl; and likewiſe with an Oyl dyed Green with a Tincture of Copper. And for a like Reaſon the Water which is carried over with Oyls diſtilled in an Alembick, appears White, as long as the globular Particles of Oyl Swim in it; and hot Water is obſerv'd to be conſiderably Whiteſt and Opacous when the hot Vapours diſper'd through it, ſtop the Paſſages of the Rays of Light, and cauſe them to fly from it, more plentifully upon the Eye; ſo that I am apt to think, that the Superficies of white Bodies may as well be convex, as ſmooth, provided the Superficies be ſo ſet with

Specular Particles, as to reflect the Rays of Light plentifully upon the Eye; for it is not only obſerv'd, that the globular Particles of Oyl, make the Water they are mix'd with appear White; but the ſame Colour is likewiſe reflected, from Powdered Glaſs, and even ſeveral Threds of it laid together; ſo that it is not, according to the Opinion of ſome, requiſite that the Particles of a white Body, ſhould be altogether Globular. And I have obſerv'd, that Snow look'd upon, with a Microſcope, appear'd to conſiſt of ſlender Icicles of ſeveral ſhapes. And I remember, that by contuſion, I have obtained a whitiſh Powder of Granates, Glaſs of Antimony, and Emeralds; and the Salt of Venereal Vitriol, Powdered, will comparatively with the Entire Chryſtals, exhibit a conſiderable Degree of Whiteneſs.

And as a Body which is not White, may acquire that Colour, by a Change of the Texture of its Parts; ſo one that is White, may be deprived of that Colour: Thus Silver being firſt bruſh'd, and then boyled with Salt and Tartar appears White; but becomes Specular by being rubb'd with a Piece of Steel, the protuberant Parts, being by that means depreſs'd into a continu'd Superficies, and reflecting the Image of a lucid Body, whereas before the innumerable little *Speculæ* reflected the Rays of Light more confuſedly.

A Mechanical Account of Blackneſs.

From what hath been ſaid of Whiteneſs, we may be able to gueſs in ſome Meaſure of the Reaſon of Blackneſs, concerning which Quality *Gaſſendus* ſays, *Exiſtimare par eſt, Corpora ſuapte natura nigra conſtare ex particulis, quarum Superficiecula*

tiecula ſcabræ ſunt, nec facilè lucem extrorſum reflectunt: So that Black differs from White, in as much as the Particles which are reflected externally by the one, are deaded by the other, and not reflected outward, either becauſe the Superficies hath ſuch protuberant Parts, as reflect the Rays internally, or being ſoft and pliable yield to the Impreſs of thoſe lucid Parts that ſtrike againſt them; ſo a Ball, that would fly back from a Stone, will ſcarce at all Rebound from a Net or Mud; tho' the latter Explication I think the leſs propable, becauſe ſeveral Bodies are Black, whoſe Surfaces are ſcarce of ſo yielding a Texture, except their peculiar Texture would render them more capable of being worked on, by the Rays of Light, than other Bodies, otherwiſe ſofter than they.

But whatever is the Cauſe, why the Beams of Light are very ſparingly reflected from Opacous Bodies; that that is the Reaſon of Blackneſs will be rendred probable if we take notice, that if a black Subſtance be held partly in the Sun-ſhine, and partly out, that Part will appear Blackeſt, which is leaſt Shone upon; and if the rough Surface of a black Marble be well Poliſh'd, and brought to the Form of a Concave *Speculum*, it will repreſent the Image of the Sun without dazling the Eyes, and will not in a long time ſet Wood on Fire, tho' a leſs *Speculum* of Matter of a more reflecting Nature would cauſe it to Flame in a Trice.

And to this I ſhall add, that having ſet a white and a black Marble Mortar in the Sun, the Black one collected the Rays of the Sun, ſo as to form a Focus much more conſpicuous

and hot than the other, by which they were more diſpers'd, and reflected a glaring Light. And the Beams of a Candle being caſt upon two Pieces of Marble, through a round Hole, half an Inch *Diameter*, the Circle of Light on the Black one, tho much leſs Luminous, was better Defin'd.

And for a further Confirmation of our Hypotheſis, I ſhall add, that when the Rays of Light fall on the Holes in linnen Cloth, or the Mouth of a Well, thoſe Parts are much Darker, the Beams of Light being not reflected back upon the Eye; And even black Velvet, being ſtroak'd up and down, ſeem'd much Blacker one way than the other, the ſilken Piles when inclin'd, reflecting a greater Number of Rays to the Eye, than the Tops of them were able to do, which make but a ſmall Part of the Superficies: And I have obſerv'd, that a Cart-load of Carrots, appear'd much more Dark when the Ends of them were towards me, than when a greater Number of Rays were reflected to the Eye by the ſides of them. And in a dark Room it is obſerv'd, that if the Light falls upon a black Cloth, the reflection from it is not near ſo ſenſible as if a White one be employ'd.

And I have obſerv'd, that a Piece of Tile being partly colour'd Black, and partly White, the Red was much hotter than the White, tho' not ſo hot as the Black Part: And it hath been obſerv'd in *Italy*, that black Marbles expos'd to the Sun were much hotter than White ones, tho' it is obſerv'd, that the black Marble is much more ſolid than White. And it is further obſerv'd, that Rooms hung with Black are much

much warmer than others, ſo that a Lady who was of a Tender Conſtitution was us'd to complain that ſhe was apt to take Cold, after ſhe had viſited Perſons whoſe Rooms where hung with Black. And I am told, that in hot Countries, Eggs colour'd Black, and expos'd to the Sun, would be roaſted by it. And I have obſerv'd them in *England* to acquire a conſiderable Degree of Heat by being expos'd to the Sun in the Summer-time Blacken'd over.

And not only the blind *Dutch-man*, but as *Bartholinus* ſays, a blind Earl of *Mansfield* could diſtinguiſh White from Black by the Roughneſs of the latter.

And for theſe Reaſons I am the rather inclin'd to believe the Doctrine propos'd, leaving it to be determin'd by Experience, whether the Beams of Light be reflected from opacous Bodies, and ſo differently modified before they reach the Eye, or whether from white Bodies they are not mov'd more briskly.

CHAP. VI.

Experiments in Conſort, concerning Whiteneſs and Blackneſs.

EXPERIMENT I.

Several Experiments concerning Whiteneſs & Blackneſs.

TO ſhew that the Colours of two diaphanous Liquors, may be deſtroy'd by a Change of Texture; Satiate warm Water with Sub-

Sublimate, and having filtered it through Cap-paper, to render it clear and limpid; if a few drops of Spirit of Urine be drop'd into two Spoonsful of it, the mixture will immediately become White; yet by an addition of *Aqua fortis* it will again become Tranſparent, and will become White again, with Spirit of Urine; and the like hath ſucceeded in other Experiments as well as of theſe.

EXPERIMENT II.

IF a Solution of Vitriol be ſhaken with an Infuſion of Galls diluted with Water, it will turn it Black; but by an addition of a few drops of Oyl of Vitriol, it will preſently lay down it's dark Colour and become Tranſparent; but upon an addition of Salt of Tartar diſſolv'd, it will again acquire a Blackneſs; and tho' this Ink be pale, yet when Dry, it is very Black. The like ſucceeded with common Ink, but not ſo eaſily, the Operation of the Salts being hindred by the Gum. And here I ſhall take Notice, that tho it be generally allow'd, that alkalizate Salts will not precipitate Bodies, except firſt diſſolv'd in ſome *Acid Menſtruum*; Yet I have try'd, that a *Lixivium* of Pot-aſhes, being pour'd upon Decoctions of Vegetables, would precipitate a curdled Matter, which would be left behind in the Filtre. And in making the firſt Ink, ſeveral Particles of black Matter, would be ſeperated by a Filtre; and when the Ink was made Clear again by the Oyl of Vitriol, the Salt of Tarter ſeem'd to precipitate and to unite

thoſe

thoſe Particles of Matter which were diſſolv'd by the corroſive Oyl.

And to ſhew, that Galls are not ſo requiſite to the making of Ink, as they are generally ſuppos'd, I added a few Drops of a Solution of Vitriol, to a Decoction of Roſe Leaves, upon which it turn'd black, and changed that Colour for a deep Red, when *Aqua Fortis* was added to it, which was reduc'd to a Black again by Spirit of Urine. And tho' upon a Mixture of Liquors, mention'd in the Second Chapter of this Hiſtory of Colours, a black Colour immediately emerges, yet both the Infuſion of *Orpiment* and a Solution of *Minium* were before they were mix'd, limpid and Colourleſs.

EXPERIMENT III.

THE *Caput Mortuum* of white Harts-horn diſtill'd in a Retort will be black, which, that it depends on the change of it's Texture only is evident, ſince the ſame happens if it be diſtill'd in Glaſs Veſſels: Yet by Calcination in open Veſſels, it will regain it's priſtine Whiteneſs. Ivory burnt yields a curious black, and ſo does the burnt *Caput Mortuum* of Tartar; but if it be throughly calcin'd it will be white. So white Woods, as Hazel, will yield a black Charcoal and whitiſh Aſhes, and even Animal Subſtances grow black by being burnt, and white when perfectly calcin'd.

EXPERIMENT IV.

THO' it be held as a Maxim by ſome Philoſophers and moſt Chymiſts, *viz. Adusta nigra, ſed perusta alba*, yet I have try'd, that Alabaſter burnt yields a Yellow; and Lead calcin'd forms a red *Minium*, which urg'd further by the fire, turns to a Glaſs darker than *Minium*. So likewiſe white *Calx* of Antimony yields a Glaſs of a red Colour, deeper than the *Calx* of burnt Antimony. And tho' common Glaſs of Antimony adulterated with *Borax* is of a more diluted Colour, yet by being urg'd with a violent fire, it's Colour was heighten'd. Blew Vitriol burnt till it may be rubb'd to a Powder betwixt one's Fingers, will acquire a white Colour; but if urg'd by a greater Heat, it will paſs through other Colours, as Gray yellowiſh and red, and when it is almoſt calcin'd throughly, it will be of a dark Purple, near to a black Colour. To theſe I may add, that *Crocus Martis per ſe*, is not ſo near a White, as the Iron it is prepar'd from. And that judicious Traveller *Bellonius* tells us, that a white Charcoal is made of the Wood of *Oxyceder*.

EXPERIMENT V.

THO' Camphire kept in cloſe Glaſſes would not loſe it's Colour by Heat, yet being ſet on fire in the free Air, it emitted Smoak copiouſly, and a Concave Glaſs with a Hole in the Middle being turn'd upon it, it continu'd burning, and cover'd the inſide of the Glaſs, with

with a black Soot, which was ſo copious, that the whole Subſtance of the Camphire ſeem'd converted into Soot.

EXPERIMENT VI.

REctify'd Oyl of Vitriol being gradually mix'd with Eſſential Oyl of Wormwood drawn over with ſtore of Water in an Alembick, this Mixture was diſtill'd in a Retort, where the *Caput Mortuum* that remain'd was black; and the like ſucceeded with Oyl of Winter-Savory made uſe of inſtead of the Oyl of Wormwood.

EXPERIMENT VII.

TO render yellow Wax white, put a ſufficient Quantity of it into a Bolt-head, with Spirit of Wine, and place it in a Sand-heat, gradually increas'd till the Wine begins to boil; and then, the Wax being melted, the Mixture will be white; which, upon an Evaportion of the moſt ſubtle Parts of the Wine will ſubſide into leſs Room than before. And one thing remarkable in this Experiment is, that the yellow Colour will neither remain in the Wax, nor the Spirit of Wine ſeparated by a Filtre of brown Paper whilſt it is hot.

EXPERIMENT VIII.

TWO Parts of Sublimate being mix'd with one of Tin-glaſs and ſublim'd together, the Matter which aſcended was of a peculiar Tex-

Texture, made up of thin, ſmooth, ſoft and ſlippery Plates, much like the Scales of Fiſhes, and of a ſhining Colour, much like *Orient* Pearls.

EXPERIMENT IX.

IF a Mixture of Gold and Silver be caſt into *Aq. Fortis*, the Gold falling to the Bottom will be turn'd black, tho' neither the Silver or *Aq. Fortis* were of that Colour. It is look'd upon by Alchymiſts, that a Mineral abounds with Gold, if it precipitates a black Powder: And it hath been obſerv'd, that Gold and Silver refin'd would ſully white Cloth, by rubbing them on it: And I have likewiſe taken notice, that Pens would be colour'd black, by a Silver caſe I kept them in.

EXPERIMENT X.

THAT a Solution of Silver will colour Hair black, hath often been found. And I have obſerv'd, that Silver diſſolv'd in *Aq. Fortis*, and evaporated *ad ſiccitatem*, and clear'd from their greeniſh Blewneſs by a ſucceſſive Affuſion and Evaporation of fair Water; this *Calx* being laid either upon the Skin or Hafts of Knives, would ſtain them with a laſting black Colour.

EXPERIMENT XI.

IN order to diſcover the Reaſon of the Blackneſs of *Negroes*, and the Colours of Foxes and

and Hares as well as other Animals, I ſhall ſubjoyn ſome Collections I have made for that purpoſe. And firſt, tho it is believ'd, that the Blackneſs of the Skins of *Negroes* depends on the Heat of the Sun, which in other hot Countries is obſerv'd to darken the Complexions of Men, more than in *England*; yet I am apt to believe, that ſomething elſe is requiſite to the Production of thoſe Colours, beſides the Influence of the Sun, ſince we ſee that Infants are of the ſame Colour. Beſides, in other Places of the ſame Latitude, the People are obſerv'd to be at the moſt but Tawny; and ſeveral Nations in the Empire of *Æthiopia* ſituated almoſt under the *Torrid Zone*: And it is obſerv'd by Travellers and Navigators, that there are very few Blacks in *America*, tho' the New World contains many Climates, and reaches from one Tropick to another. And tho' the *Danes* are whiter than the *Spaniards*, yet it is obſerv'd, that the *Swedes* who likewiſe Inhabit thoſe cold Countries are not ſo white as them. And I have ſeen ſeveral *Ruſſians*, who were of a much browner Complexion than the *Danes*, tho' theſe are ſaid to proceed from a Race of *Tartars*, for in one Province the *Muſcovites* are obſerv'd to be much whiter. And I am told, that *Negroes* live not far from the *Cape of good Hope*, which is beyond the *Southern* Tropick, tho' near the ſame degree of Latitude *Northward*, Divers *American* Nations are not inhabited by *Negroes*, and the Inhabitants of *Candia*, ſome Parts of *Sicily*, and even *Spain* are not ſo much as *Tawny Moors*. And even the Inhabitants of *Greenland* are obſerv'd to be of an Olive-colour, or a darker Complexion.

But,

But nevertheleſs, that Coldneſs may in ſome meaſure contribute to Blackneſs or Whiteneſs, appears from what hath been obſerv'd in *Ruſſia* and *Livonia*, *viz.* that Hares and Foxes become white in Winter, and regain their genuine Colours again in the Summer; yet in *Curland*, as *Olaus Magnus* relates, they vary not their Colour in the Winter; tho' this Country is only ſeverv'd from *Livonia* by the River *Dugna*, where it may ſeem too ſtrange to be credited, that ſo ſmall a compaſs as that River takes up, ſhould diverſify the Effects of Cold ſo much; and the ſame Objection may be made in reſpect of the *Moors*, ſince *Negroes* inhabit on one ſide the River *Cenega*, and Tawny colour'd People on the other.

Another Opinion concerning the Colour of *Negroes* is, that it was a Curſe entail'd upon the Race of *Cham*. But not to ſhift off the natural Cauſe of that Colour, by flying to a Principal and Univerſal Cauſe, whilſt there is no neceſſity of it; not to urge, that the Curſe pronounced by *Noah*, was, that he ſhould be a Servant of Servants, which was fulfill'd, when the Poſterity of *Sem* ſubdued the *Cananites*; I ſee not why Blackneſs ſhould be eſteem'd a Curſe, ſince the *Negroes* are ſo much content with it, that they paint the Devil white: Nor do I think Blackneſs inconſiſtent with Beauty, ſince it conſiſts in a Sumetry of Parts and good Features in the Face; ſo that Blackneſs cannot reaſonably be accounted a Curſe, except that Colour cauſes their Bodies to be more ſcorched by the heat of the Sun, than if it were white, according to the Doctrine above deliver'd.

But

But I am rather inclin'd to think, that they proceed from ſome ſeminal Influence, ſince *Negroes*, as well as *Americans* Tranſplanted, retain their Proper and Native Colours; and Twins which are got by the *Portugals* and *Æthiopian* Women, are, ſometimes, one of them white, and the other black. And how far ſeminal Impreſſions contribute to the differences of Organical Parts, appears from the flat Noſes, and Blabber Lips of moſt *Negroes*. To which may be added, the little Feet of the *Chineſes* and the *Macrocephali* mention'd by *Hypocrates*. And it hath not only been obſerv'd, that a ſort of Hens want Rumps; but I have ſeen a Raven perfectly white. To which I ſhall add, that a Lady, who was a devout Catholick, looking upon the Pebbles at the Bottom of St. *Winifred*'s Well, ſome time after bore a Child whoſe Skin was cover'd with the Reſemblance of Red Pebbles.

To what hath been ſaid of *Negroes*, I ſhall add, that the *Epidermis* only is black, the Skin under that, being as white as that of the *Europeans*; ſo that a Child who had the Meaſles or ſmall Pox, after thoſe Pimples had broke, was cover'd with a multitude of white Spots: And it is atteſted by ſeveral, that the *Negroes* when firſt born, are red or white like other Children, but in a few days acquire the Colour of their Parents: Nevertheleſs, ſome of them that are born under the *Torrid Zone*, continue white, and are preſented to the King, and always wait on him. Theſe are uſually, as *Purchas* witneſſes, brought up in Witchcraft, and the People ſtand in great Awe of them.

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EXPERIMENT XII.

NOT only common Crab's Eyes and Pearls, but Coral and *Minium* diſſolv'd in Spirit of Vinegar, may be precipitated by Oyl of Tartar into white Powders: And not only Silver and Tin, but Lead and Quickſilver diſſolv'd in *Aqua Fortis* will yield a white Precipitate, upon an Affuſion of ſalt Water, and ſo will Tin-glaſs; and the Calces will be much better colour'd, if they be precipitated with Oyl of Vitriol inſtead of Oyl of Tartar. And black mineral Antimony may, by the Salts which concur to the Compoſition of Sublimate, be turn'd into a rectify'd Butter of Antimony, which upon an Affuſion of fair Water, will precipitate the white Powder call'd *Mercurius Vitæ*; and the like Powder may be made of Antimony without any Addition at all: And the like white Subſtance will be precipitated by an Affuſion of Water, upon a Solution of ſulphureous Gums in Spirit of Wine. And to theſe I may further add, that Water being pour'd upon a red Tincture of *Benjamin*, drawn with Spirit of Wine, will turn it white: But if ſuch ſeemingly white Bodies ſtand for ſome time, unſtirred, a reſinous Subſtance will of it ſelf ſubſide; And if acid Spirits be dropp'd upon a red Solution of Sulphur in Pot-Aſhes, or ſome other ſharp *Lixivium*, the precipitated Sulphur, before it ſubſides, will turn the red Liquor white. But tho theſe ſeveral Bodies yield white Precipitates, yet all will not, ſince Gold yields a yellow one, whether precipitated by Oyl of Tartar, or Spi-

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THO it be in ſome meaſure true, that White is a Colour like the *Materia Prima*, fit to take any Form, and that Black is a Colour which is not to be changed for another; yet it does not hold univerſally true; for tho' the Ingredients which dye a Body Black, by infecting other Ingredients uſually hinder it from taking a higher Colour; yet we have made it appear, that Inks of different kinds might be depriv'd of their Blackneſs. And I have ſometimes turn'd black Pieces of Silk, yellow, with Oyl of Vitriol. And as for Whiteneſs, we ought not to believe it ſo eaſily deſtroy'd without Caution and ſome Reſtrictions: For Lead is by Calcination, turn'd into a red Body; and Tin is reduc'd into a white *Calx*, and the common Putty ſold in the Shops, is made up of half Tin and half Lead, and yet, notwithſtanding the Lead, the Putty is white, without diſcovering any Mixture of *Minium.* And ſo if Copper be mix'd by Fuſion with half the Quantity of Tin, they will yield a Subſtance, in

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in which the white Colour is much more tranſparent, than the reddiſh Colour of the Copper.

And on this occaſion I ſhall add, that Arſnick being colliquated in Copper, blanch'd it; but the white Mixture being kept upon the Cupel, till the Arſnick flew away, the Copper return'd to it's Priſtine Colour. And to ſhew how much the white Colour of a Metal may obſcure the Colour of thoſe it is mix'd with, I ſhall add, that a fourth Part of Gold being mix'd with Silver, the yellow Colour of the Gold was not to be diſcern'd; but when it was rubb'd on a Touch-ſtone, *Aqua Fortis* would take off the Silver, and leave the Gold behind it, upon the Stone.

EXPERIMENT XIV.

A Poliſh'd Piece of black Horn being ſcrap'd with a Piece of Glaſs, and laid upon a black Beaver Hat, ſeem'd white enough; but being plac'd upon white Paper, the Colour of that eclipſed the Whiteneſs of the Horn, and made it appear like dirty Linnen. From which Experiment it appears, that Colours depend neither on ſubſtantial Forms, nor the Hypoſtatical Principles of the Chymiſts, but on a Reflection of the Rays of Light, variouſly modify'd by their new ſuperficial Texture.

EX.

EXPERIMENT XV.

IT is Taught by the Chymiſts, that Blackneſs depends on *Sulphur aduſt*. But beſides what hath been already offer'd as the cauſe of Blackneſs, I ſhall add, in reference to the Opinion here propos'd, that common *Sulphur* ſublim'd, is far from black, but it is in a great meaſure yellow, and rather more than leſs white than before; and when ſet on fire to make *Oleum Sulph. per campanam*, it yields very little Soot; and the Flame yields ſo little, that it will ſcarce black a white Sheet of Paper; and it is obſerv'd rather to whiten than to black Linnen, and makes red Roſe Leaves grow pale and not black. And I have ſeen a Piece of fix'd Sulphur, which was kept ſeveral Weeks in a violent Heat, yet it had no other Colour when cool, but a pure red. And not only Sulphur, but that ſulphureous Body Camphire may be kept in a violent Heat without acquiring any thing of Blackneſs: Nor will inflammable Spirit of Wine, diſcolour a piece of Paper held over it whilſt it conſumes. And Tin calcin'd, yields not a black, but a white *Calx*; and not only the Charcoal made of *Oxy-Cedar* is white, but the Smoak of *Tinby* Coals is obſerv'd rather to blanch Linnen than black it: To what hath been ſaid we may add, that the Ingredients of our Ink were not hot but cold; and Juice of Limons will blacken the Blade of a Knife, except it be quickly wiped off, tho' no actual Heat intervenes to aduſt the Sulphur. And if the Black-

neſs of the Ink depended on aduſt Sulphur, it might be demanded, what became of thoſe aduſt Particles, when the Liquor, by a few drops of Oyl of Vitriol, loſt that Colour. Beſides, Soot it ſelf may have it's Texture ſo far alter'd, as to yield a Cryſtalline Salt and a tranſparent Colour.

But were it allow'd, ſince Aduſtion renders ſome Bodies black, that that Colour depended on a torrify'd Sulphur, it might be further demanded, what gives torrify'd Sulphur that Colour; and it might be queſtion'd, what makes a Window half ſhut, at a diſtance to appear black, ſince it hath no Acceſs of torrify'd Sulphur upon that Poſture, but only the Rays of Light are not ſo plentifully reflected by it, as is requiſite to affect the Senſory with a more lively Colour; But to conclude. What the Chymiſts teach of Blackneſs, to me ſeems to come to no more, than if in anſwer to an Enquiry after the Cauſe of Salivation, they ſhould tell us, that the ſeveral kinds of Precipitates of Gold and Mercury, and likewiſe of Quickſilver and Silver ſalivate upon Account of the *Mercury* that abounds in them, where we are ſtill at a loſs to know why *Mercury* ſhould have that Effect.

CHAP.

CHAP. VII.

Containing promiſcuous Experiments about Colours, being the Third Part of the Experimental Hiſtory of Colours.

EXPERIMENT I.

Promiſcuous Experiments concerning Colours.

TO ſhew how much the Diverſity of Colours repreſented by Opace Bodies, depend on the Mixture of the Rays of Light with Shades more or leſs as to Quantity, or as to Interruption, I ſhall ſubjoyn the following Notes.

Paper ſtain'd with ſeveral Colours, plac'd in a dark Room whoſe Window was *Southward*, the Beams of Light entring in at a Hole 3 Inches Diameter; the White yielded the brighteſt Reflection. Red gave a Reflection ſtronger than Green or Blew, whoſe Colours were ſcarce diſcernable, and of an equal Brightneſs. Yellow reflected more Light than either Green or Blew. Red reflected more Light than Purple, and ſo did Blew. Marble Paper ſleek'd reflected the Rays of Light unſtain'd, but not ſo bright as white Paper. Purple ſeem'd to reflect more Light, than a dark Green. In compounding Colours by Reflection we obſerv'd, that if the Colours were not ſtrong and ſomewhat gloſſy, the reflected Rays would not form a compound Colour on the Wall.

EXPERIMENT II.

I Have often taken notice, that white Linnen would receive and reflect the Colour of a red Silk Waſteoat in a Light Room; tho' it be generally believ'd, that a dark Room is requiſite to make the Colour of one Body viſible by Reflection from another.

EXPERIMENT III.

COlour'd ſheets of Paper held betwixt the Light and the Eye, at the Hole which was made in a dark Room, the Colours were each of them repreſented to the Eye ſingle, but by placing one ſheet of Paper before another, the Rays of Light paſſing through the Blew and Yellow exhibited a darker Yellow; but a finer Paper which was blew, being made uſe of inſtead of the former, they afforded a good Green. The yellow and red repreſented a dark Orange colour'd Red. The Purple and Red, appear'd of a deeper Scarlet. Purple and Yellow made an Orange Colour. Green and Red a dark Orange Tawny. Green and Purple, made a Purple more dirty. Blew made the Purple deeper and more lovely. Red Marble and yellow repreſented a Scarlet; but the Colours which were thus compounded vary'd much, as the Colours of the Paper were deeper or more ſlight, and as the Paper differ'd in fineneſs.

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EXPERIMENT. IV.

IN the aforesaid darkened Room we plac'd a Triangular Prismatical Glass in a convenient Posture, and observ'd no less than four Reflections and three Refractions; and by hiding sometimes one Part of the Prism, and sometimes another, we found the Rays of Light as the following Scheme represents (*See Plate* 5. *Fig.* 5. *See Plat.* 5. *Fig.* 5.

The Explication of the Scheme.

P. P. P. An *Æquilatero-triangular* Crystalline Prism, of whose Edges *P.* is placed next the Sun.

A. B. and *α. β.* Two Rays from the Sun, falling on the Prism at *B. β.* and thence partly reflected towards *C.* and *γ.* and partly refracted towards *D.* and *δ.*

C. and *β γ.* Those reflected Rays.

D. and *β. δ.* Those refracted Rays which are partly refracted towards *E.* and *ε.* and there represent a *Iris* 345, denoting the five Consecutions of Colours, *Red*, *Yellow*, *Green*, *Blew* and *Purple*, and are partly reflected towards *F.* and 3.

F. and *δ* 3. Those reflected Rays which are partly refracted towards *G.* and *ζ.* Colourless, and partly reflected towards *H.* and *θ.*

H. and 3. *θ.* Those reflected Rays, which are refracted towards I. and 1. and there represent another fainter *Iris*, the Colours of

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F. and *δ* 3. Those reflected Rays which are partly refracted towards *G.* and *ϖ.* Colourleſs, and partly reflected towards *H.* and *θ.*

H. and 3. *θ.* Those reflected Rays, which are refracted towards I. and ι. and there represent another fainter *Iris*, the Colours of

which are contrary to the former 54321. ſignifying, *Purple*, *Blew*, *Green*, *Yellow*, *Red*, ſo the Priſm in the Poſture repreſents four Rainbows.

EXPERIMENT V.

WE obſerv'd, that in a light Room, the Priſmatical *Iris* might be reflected, without loſing any of it's Colours, from a flat Looking Glaſs, the Surface of Water, or a Concave Looking-Glaſs; and that Refraction did as little deſtroy their Colours as Reflection: For tho' by a Burning-Glaſs one Part of the *Iris* would appear either beyond or on this ſide the other, yet the Colours would appear as vivid in the diſplac'd Part, as in the other. To which I ſhall add, that the moſt part of the Priſm being cover'd with an opacous Body, ſo that, the Rays falling but on a ſmall Part of it, the *Iris* was but little, yet the Colour appear'd to be the ſame through a Microſcope as to the naked Eye.

EXPERIMENT VI.

COlours which appear in a dark Room are ſo dim, that if the Light of the Sun be let in, they preſently diſappear; which I experienc'd by caſting the converging Beams of the Sun upon the Priſmatical *Iris*, by a concave *Speculum*; and if theſe Rays only croſs'd the Rays of the *Iris*, before they fell to ground, they would likewiſe diſappear.

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EXPEEIMENT VII.

TRying whether the Colours of opacous Bodies would be vary'd, as they were in a different Position in reference to the Eye, or according to the nature of the Lucid Bodies that ſhine upon them; we look'd upon ſeveral Pieces of Paper by Candle Light; and found, that Yellow was much fainter, than in the Day. The Red was little alter'd. A deep Green ſeem'd to be a dark Blew; but, being held by a Blew, appear'd Green; and much blewer than at the firſt, when look'd upon by a Yellow. Blew, look'd like a deep Purple. Purple was very little alter'd. Red look'd upon with the Yellow, made it appear like brown Cap-paper.

EXPERIMENT VIII.

SUſpecting the Flame of a Candle to be tinged yellow with it's Fuel, we look'd upon it through a deep blew Glaſs; and obſerv'd, that through that it appear'd green; a Colour which emerges from a Compoſition of an obſcure blew and a Yellow. And for a like Reaſon, at the firſt ſight it is not eaſie to diſtinguiſh a Paper from a light Yellow Paper; and other white Bodies reflecting the Rays of Light leſs troubled or more ſincere than other Bodies.

EXPERIMENT IX.

A Leaf of Gold being held betwixt the Light and the Eye, ſeem'd full of Pores like a

ſieve, and ſo modifi'd the Rays of Light that came through it, that they appear'd to the Eye of a greeniſh Blew; and the like ſucceeded with a Leaf of Silver.

EXPERIMENT X.

I Am told that *Lignum Nephriticum* is us'd in the Country where it grows as an excellent Medicine againſt the Stone; which Virtues *Monardes* likewiſe aſcribes to it given in Infuſion. An Infuſion of this Wood, if it be not too ſtrong will appear, betwixt the Eye and the Light, to be of a golden Colour, except that upon the Top it will be cover'd with a ſky Colour'd Circle; but if your Eye be plac'd betwixt the Window and the Vial, the Liquor will appear to be of a lovely Blew. And this Experiment hath ſucceeded by Candle Light: If the Liquor be held partly before the Eye and a Light, and partly betwixt the Eye and an Opacous Body, it will half of it ſeem of a golden Colour, and half a Blew; but if turning your back on the Window you obſerve the Liquor as it is poured out, it will at the firſt ſeem Blew; but when it hath fallen lower, and the Rays of Light penetrate it more, it will ſeem Particouloured. If a little of this Tincture be pour'd into a Baſin of Water, partly in the Sun Beams and partly ſhaded, it will afford ſeveral pleaſing *Phænomena*. If ſome of it be pour'd upon white Paper, the drops about it will appear of different Colours, as the Poſition of the Eye in reference to them varies; and when it is pour'd off, the Paper will be dyed Yellow; and

if

if this be plac'd in a Window in the Sun-ſhine, and a Pen held betwixt the Sun and part of the Paper, the Verge of the Shadow next the Body that Cauſes it will be Golden, and the other Blew. Which *Phenomena* proceeded from the moſt ſubtile Parts of the Wood Swimming in the Water, and in ſeveral Poſitions variouſly reflecting the Rays of Light. Some of this Liquor being carefully Diſtill'd, it yielded a colourleſs Limpid Water, a deep ceruleous Liquor remaining behind. Spirit of Wine and Salt of Harts-horn, being mixed together I obſerv'd, that it required a certain proportion betwixt the Liquor and the Salt, which enabl'd it to vary it's Colour. So that tho' I was induc'd to believe that our Tincture receiv'd its Colour from a Salt diſpers'd through it, yet I ſuſpected, that this Salt would be either alter'd or incorporated by Acid Salts; and accordingly dropping Spirit of Vinegar into ſome of the Tincture it loſt its Blew, but not the Golden Colour; but upon an Affuſion of Oyl of *Tartar per deliquium*, that correcting the Acid Salts, it preſently regain'd its Blew Colour again, the ponderous Tartarous Liquor firſt altering the bottom of the Liquor and gradually riſing again.

And ſince *Kercherus Art. Mag. lucis & umbræ lib.* 1. *Part* 3. writes ſomething of this Exotick Plant, which agrees not with our account of it, ſince he ſays it will according to the difference of the Medium, in reſpect of Light and its ſeveral Poſitions, vary its Colour; yet from the Account he gives of it, it appears, that the Wood he made uſe of, was different from Ours ſince

ſince he calls it a white *Mexican* Wood, whereas ours, as *Monardes* witneſſes is brought from *Nova Hiſpania*, and is not of a White, but a darker Colour, except on the outſide, which part is much weaker than the other. Beſides, he tells us that his Tincture was like Spring Water when held betwixt the Light, whereas ours is Yellowiſh or Reddiſh, as the Tincture is weaker or ſtronger. And ſince he tells us, that the Tincture will afford all ſorts of Colours, and reſume a ceruleous Colour in the Dark, I could wiſh to know how he was convinc'd of the Latter; and as for the Former, I have tryed that it would not at all Anſwer. Tho' this I muſt needs own, that having held a Tincture of *Lignum Nephriticum* in the Rays of the Sun, in a darken'd Room, partly in and partly out, and alſo, wholly out of the Beams but partly near them, it afforded a much greater Variety of Colours than in a lighten'd Room.

In this Experiment it is not a little to be admir'd, that the Blew Colour ſhould be ſo eaſily deſtroy'd, whereas the Yellow Colour is ſo durable; and further, that Acid Salts ſhould deſtroy it and Sulphureous one Reſtore it.

A Corollary of the Tenth Experiment.

Acid and Sulphureous Salts diſtinguiſh'd.

THis Experiment may give us a hint towards a Diſcovery of ſome way to diſtinguiſh whether Liquors abound with Acid or Sulphureous Salts; for if they be Acid, they deſtroy the ceruleous Colour; if Sulphureous, they reſtore it. And by this Method we have found, that, tho' it hath been doubted what was the

Nature

Nature of Quickline, it abounds with *Lixiviate* rather than Acid Salts. But of what uſe this Tincture may be, where neither Acid nor Alkalious Salts are Predominant, I leave to be determined by Experience; ſince I found not that Spirit of Wine, Spirit of Tartar freed from Acidity, or Chymical Oyl of Turpentine would reſtore the cerulcous Colour of this Tincture, when it diſappear'd upon a mixture of Oyl of Turpentine.

EXPERIMENT XI.

I Have a flat Piece of Glaſs, which held betwixt my Eye and the light appears Yellow; but being held ſo, that it reflects fewer Beams upon the Eye, it degenerates into to a pale Blew. And the ſame Piece of Glaſs being held Perpendicular to the Horizon, that Part which the Sun ſhines on will be of a more dilute Yellow, than the other which is ſhaded; but if it be held Perpendicular to the Horizon, the ſhaded Part will be of a Golden Colour and the other Blew; if the Sun-beams paſs through it upon a white Paper, they will repreſent a Yellow; yet the Poſition may be ſo vary'd, as to yield a mix'd Colour more or leſs inclining to Yellow in ſome Places and in others to Blew. *N.* 1*ſt* In trying of theſe Experiments, the Sun-beams muſt fall upon the ſuperficial Parts of one ſide of the Glaſs, on which we muſt take care to keep our Eye. And we have prepar'd a ſort of Glaſs which would anſwer our expectation by laying a Leaf of Silver on one ſide, and urging it with a ſtronger Fire than uſual. And one thing

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in this Experiment remarkable was, that whereas common Artificers colour their Glaſs by putting a Calx of Silver, Calcin'd without corroſive Liquors, and temper'd with fair Water, on the Plates of Glaſs when they burn them, theirs appears Yellow whatever ſide is held to the Eye, or in whatever Poſture, but this of ours held betwixt the Eye and the Light appear'd Tranſparently Yellow; but the Eye being placed betwixt the Light and it, it appear'd Blew, and not in the leaſt Tranſparent.

EXPERIMENT XII.

IT is worth obſerving, that, tho Painters can imitate moſt Colours which are to be met in Nature, yet they make uſe of no more than, *White*, *Black*, *Red*, *Blew* and *Yellow*, to produce all their Compoſitions. Thus Black and White repreſent ſeveral ſorts of Grays: Blew and Yellow, Greens; Red and Yellow, Orange Tawny; Red with a little White, a Carnation; Red with an Eye of Blew, a Purple; and by a Decompoſition of all theſe, they repreſent what Colours they pleaſe. But in producing of Colours it is to be obſerv'd, that we muſt take care that the Pigments be ſo harmleſs as not to deſtroy each others Textures, for then the ſucceſs will be fruſtrated.

EXPERIMENT XII.

WE obſerv'd that the Colour of a Body did not only ſeem compound, when we look'd through two Glaſſes at once upon it, but when

when the Beams of the Sun were caſt through a double Glaſs, the penetrating Beams would be ting'd with the compound Colour. But the Rays of Light caſt by reflection on a Sheet of Paper from ſeveral varniſh'd Glaſſes, they were ting'd with none of the Colours except Yellow, ſo that I ſuſpected the Beams of Light to penetrate deeper into that Subſtance than others, and to be ting'd with the Varniſh; which Gueſs I was confirm'd in, by ſpreading a little tranſparent Varniſh of a Gold Colour, on a Plate of *Muſcovy* Glaſs; for the Rays thence reflected were of a Yellow Colour.

EXPERIMENT XIV.

I Not only found by Experience, that thoſe Colours, which are by the Schools, taken to be Phantaſtical, might be compounded with as much certainty as real ones; but that if thoſe Colours were deficient, the reſulting Colour would be ſo too. And amongſt thoſe Experiments I made, it was obſervable, that the Yellow Beams of an Iris paſſing through a blew Glaſs were turn'd Green. And the blew Part of an Iris caſt upon Red Cloth, would turn it Purple: And by caſting one Part of an Iris upon another Iris made by another Priſm, I could compound Colours, which would anſwer my expectation as well as with thoſe that are eſteem'd real Colours.

EXPERIMENT XV.

I Endeavour'd to try what alteration would be made in Colours by the uſe of a Colour'd Priſm; but I found, that it was too difficult to get

get ſuch as I deſir'd, ſince whatever Pigments a Priſm was Colour'd with, they would make it too Opake for our Purpoſe.

EXPERIMENT XVI.

THere are ſome Liquors which are of themſelves devoid of Colour, but when rais'd in the form of Vapours, for the time have very conſpicuous Ones; as Spirit of Nitre and *Aqua fortis*, which in the form of Vapors put on a Red or a deep Yellow. And I further Obſerv'd, that the Beams of the Sun Trajected through theſe Steams appear'd Ting'd with their Colour, and ſo did the Rays of Light, which were receiv'd from the ſetting Sun upon a Piece of white Paper.

EXPERIMENT XVII.

HAving mix'd Colour'd Powders together, I obſerv'd, that if a Liquor was made uſe of in the Mixture, the ſame Colour would not emerge as from the dry Powders. Orpiment and Yellow Oker being mix'd afford a good Green. A Yellow ſolution of Gold in *Aqua fortis* being mix'd with a blew Solution of crude Copper by ſhaking yielded a tranſparent Green: And ſo did blew and yellow Amel melted together: Whether this compound Colour proceeds from a Union of Rays, or elſe from the joint Effect they have upon the Retina, as when two Strings ſound at the ſame time they make one united Sound I ſhall not now ſtay to Examine; but ſhall briefly intimate that by a good Microſcope I could

could discern each of the Powders of the Bise and Orpiment Distinct, so that a Transposition and Juxtaposition of Parts may produce a new Colour, by variously modifying and reflecting the Rays of Light that fall upon them. So that Colours being mechanically produc'd, there is no need of substantial Forms to explicate them; nor do they seem to be such inherent Colours as they would have them to be, since they consist only of a heap of mix'd Particles of Matter. Nor does it appear, how these compound Colours should be caus'd by a Sulphur, which tho' the Ingredients must contain it, cause no such Effect there.

EXPERIMENT XVIII.

SYrup of Violets being drop'd upon Paper, and a yellow Solution of Gold mix'd with it, the result was a Red, not a Green, which was occasion'd by the Acid Salts in the Solution; so that to produce a particular Colour with certainty by the mixture of Ingredients, it is requisite they should be such as may be mix'd without altering each others Texture, for a blew Solution of Copper in Spirit of Urine, made with Syrup of Violets not a Blew, but a Green.

EXPERIMENT XIX.

TO shew that Colours may be alter'd, without any Change in the Chymical Principles of a Body, I shall urge, that essential Oyls or Spirit of Wine being shaken, till Bubbles

Bubbles riſe, they will afford, as long as they laſt, very lively Colours, and ſo does Water and Sope, made into Bubbles by Children; and ſo will Bubbles in Oyl of Turpentine and thin ones blown of Glaſs. And I have diſcern'd ſeveral Rainbows repreſented, by holding before my Eyes and the Sun, a Feather or a Piece of black Ribband.

EXPERIMENT XX.

ALmoſt any Acid mix'd with Syrup of Violets will turn it Red; but Oyl of *Tartar per deliquium* will turn it Green, and all other Alkalize Salts. And this may diſcover, what Salts are predominant in Bodies, as well as our Tincture of *Lignum Nephriticum*: Only it will not be work'd upon by ſo ſlight and weak Ingredients.

EXPERIMENT XXI.

BLew Bottle or Corn-weed being Candied preſerves its Colour a long time; and when newly preſs'd the Juice will be Blew; yet Spirit of Salt will turn it Red, and Alkalies, Green; and this being drawn upon a piece of Paper moiſten'd with an Acid, it render'd it Red. A Solution of blew Vitriol in Water, upon an Addition of a Lixiviate Liquor, or an urinous Salt, becomes Yellow: Whence it appears, that Volatile or Alkalizate Salts change not Blew into Green upon the account of an eaſie Tranſition from Blew to Green, but upon the Account of the Texture of them.

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EXPERIMENT XXII.

Italian Painters being us'd to imitate *Ultramarine Azure*, by grinding Virdigreaſe with Sal Armoniack, and leaving it to rot in a Dunghil; This gave us a hint to pour Oyl of Tartar upon a Solution of Verdigreaſe; which, tho' at firſt, the Mixture was turbid, yet being ſettl'd, it produc'd a lovely Tincture; and a *Lixivium* of Pot-aſhes, being made uſe of inſtead of this Oyl, it yielded an *Azure* ſomething Paler than the former; and if Spirit of Harts-horn be made uſe of inſtead of theſe, a greater variety of ceruleous Liquors may be obtain'd. The better way to ſeparate theſe *Azure* Liquors from their Feces, is by Decentation, than Filtration, the Lquor being, by the latter means uſually ſtain'd.

EXPERIMENT XXIII.

THo' the Fumes of Sulphur uſually whitens Roſe Leaves, yet Oyl of Sulphur *per Campanam*, heightens the Colour of their Tincture.

EXPERIMENT XXIV.

A Grain of Cochinele diſſolv'd in Spirit of Wine, and afterwards gradually in Water, it gave a Tincture to above 125000 times its weight; which is an Inſtance of the great Minuteneſs of the Parts of Matter, and of a vaſtly minute Diviſion of them.

EXPERIMENT XXV.

RIpe Privet Berries, being cruſh'd upon white Paper, ſtain it with a Purple; Yet Spirit of Salt will turn it Red, and a Solution of Pot-aſhes, Green; and ſo will Meſerion, and the Juice of Peaſe. From whence and the like Experiments before premis'd, it appears, that the Saline Parts of Bodies have a conſiderable ſtroke in producing their Colours.

EXPERIMENT XXVI.

SPirit of Salt being drop'd upon ſeveral Subſtances already Red, as Syrup of Clove-july-flower, Berries of *Spina Cervina*, an infuſion of Red Roſes, Braſil, and ſeveral others, it either made no Alteration, or render'd the Red Lighter. An infuſion of Roſes was turn'd into a dirty Colour, by an affuſion of a Solution of Pot-aſhes; and Syrup of Cloves was render'd a little more inclining to Green. Another Red Infuſion was advanc'd into a Crimſon; but the Juice of Buckthorn-berries acquir'd a lovely Green.

EXPERIMENT XXVII.

SPirit of Salt had a very ſmall Effect upon the Juice of Jaſmin; but Spirit of Urine turn'd it to a Greeniſh Yellow; and the Event was much the ſame when we try'd it with thoſe leſs Oyly Leaves, call'd Snow Drops, which appear about the end of Winter.

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EXPERIMENT XXVIII.

MAry-Gold Leaves, freſh Madder, and early Primroſes, *&c.* being rubb'd upon Paper till they Coloured it, they would be turn'd Red or Green, by Alkaliz'd Liquors; tho' ſo Acid a Salt as the Spirit of it, rather diluted them, yet it almoſt deſtroy'd the Colour of the early Primroſes; and an Alkalizate Solution turn'd the Juice of Madder Root Red, as well as the bruis'd Root it ſelf. From whence it abundantly appears, that the Effects of a peculiar Salt upon the Juices of Vegetables depends on their particular Textures.

EXPERIMENT XXIX.

A Black-berry full Ripe, and another only Red, being rubb'd upon a Piece of Paper, the Juice of the former was turn'd into a Green by a *Lixivium*; and one much fainter, by a Urinous Salt, and by an Acid, into a Red. But the unripe Berry was little alter'd by the Acid, but by the other Juices, receiv'd Impreſſions different from the former. Damask Roſes would be colour'd Red by an Acid, and Green by an Alkaly; but a Yellow *Province Roſe* by a Solution of Salt of Tartar was turn'd into a Green Blewiſh Tincture; but an Acid only diluted the Yellowneſs of the Leaves. And were I in the Iſland of *Banda*, I ſhould try what Effects theſe Salts would have on the Juice of Cloves, which I am told, are firſt White, then Green, and afterwards Reddiſh, and when dry'd, grow Black;

but the Flowers of them are ſaid to be of an excellent Blew. And one thing which deſerves our notice is, that tho' Damask, as well as red Roſes, give a red Tincture to Water acidulated, yet the one hath a purgative, and the other a binding Quality. And to what hath been ſaid under this Experiment, I ſhall add, that Mr. *Parkinſon* tells us, that Buckthorn Berries gather'd green, and bruis'd into Allum-Water, yield a yellow; when they are black they yield a Sap Green; and if they grow upon the Trees till the middle of *November*, they yield a Purple Colour. And *Cluſius* of *Alaternus* tells us, that the groſſer Parts of ſome Plants differ in Colour from each other; for the *Portugal*'s Dye their Nets blew with a Bark, and blackiſh blew with the Wood.

EXPERIMENT XXX.

TO ſhew that a change of Colour depends on an Alteration of Texture, I ſhall add, that the ſame Matter being ſeal'd up in a Philoſophical Egg, it will by Digeſtion, paſs through ſeveral degrees of Colours, before it comes to that of the nobleſt *Elixir*. And that ſeveral Subſtances will undergo changes of Colour by Digeſtion, is evident, in rectify'd Spirit of Harts-horn, Precipitations of *Amalgamas* of Gold, and Mercury, without Addition, where by a continu'd Heat, the Silver-colour'd *Amalgama* will be turn'd into a ſhining red Powder; which Effects are produc'd without an Addition or Subſtraction of Matter, by the bare change of Texture.

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EXPERIMENT XXXI

IN moſt Tinctures which the Chymiſts draw, Redneſs is the common Colour, as well as in more groſs Solutions, tho' the *Menſtruums* be colourleſs; as with Spirit of Wine, from Jalap, *Guajacum*, Amber and *Benzoin*, Flowers of Brimſtone, Turpentine, *&c.* And moſt Acid or Alkalizate Salts will with ſulphureous Bodies produce a Red, and ſo will Glaſs of Antimony; and I know an Acid which will turn Oyl of Turpentine into a Red.

EXPERIMENT XXXII.

THO' Balſam of Sulphur ſeems red, as well as other Liquors in a broad Veſſel, yet it ſtains Paper yellow; but a Tincture of Cochenele, never ſo much diluted, will ſtill remain Red.

EXPERIMENT XXXIII.

OYL of Turpentine digeſted upon white Sugar of Lead, yields a red Tincture.

EXPERIMENT XXXIV.

IF 5 Ounces of Brimſtone and *Sal Armoniack*, be diſtill'd in a Retort with 6 Ounces of Quick-Lime, in a Sand-Heat gradually increas'd, a volatile Tincture of Sulphur will be obtain'd, which is red, tho' none of the Ingredients were ſo; yet if agitated when the Veſſel it's contain-

ed in is unſtopp'd, it will yield a white Fume. And ſometimes it may be ſo drawn, that tho' the Fumes are white, yet the Liquor will dye the Fingers black.

EXPERIMENT XXXV.

WE let a Drop or two of Oyl of Vitriol fall upon Oyl of Aniſeeds coagulated, and ſpread upon white Paper, by which there was a red Colour produced with Heat and Smoak.

EXPERIMENT XXXVI.

ONE thing to be obſerv'd in the Experiments above recited is, that tho' the Colours mention'd, are eaſily produc'd; yet ſome of them preſently fade, by the Influence of the Air, or the Inteſtine Motion of their own Parts. And *Parkiſon* tells us, that Berries of that Plant, which bears *Turnſol*, a Pigment well known in Painters Shops, when they are at their full Maturity, yield a Juice, which being rubb'd upon Paper appears green, but preſently degenerates into a blewiſh Purple, upon the Cloth or Paper; and theſe being wet in Water, and wrung forth, will give it a Claret Colour. And I have obſerv'd the Red Colour of Buckthorn Berries degenerate into a dirty Grey Colour; yet by the Mixture of an Alkaly or an Acid it would put on a green or red Colour; and the ſame Succeſs we had when we dropp'd the ſame Liquor upon a Piece of glaz'd Tile. And I have obſerv'd, that Silver precipitated in *Aq. Fortis*, tho' at the firſt it is white, yet when upon a De-

Decantation of the Liquor, the Superficies becomes expos'd to the Air, it preſently turns blackiſh. And I have ſeen a ſort of Pears, which would give a red Tincture to Wine. And it is obſerv'd, that Spirit of Wine being kept upon white Salt of Tartar, acquires a red Tincture. But as for the reaſons of theſe things, and alſo why all Bodies burnt in the open Air almoſt, are black, I ſhall leave to *Pyrophilus* to enquire.

EXPERIMENT XXXVII.

SPirit of Salt pour'd on a Solution of Cochinele, or the Juice of black Cherries, renders their Colours clearer; but turns an Infuſion of Braſil yellow, the Acid Liquor in both weakening the Spirit on which it falls; for as Crimſon is a Red with an Eye of blew, ſo Yellow is but a dilated Red; and therefore Alkalizated Salts, will not only reſtore the Infuſion of *Cochinele* and Braſil to Crimſon, but will turn the yellow Juice of Madder red, and an Infuſion of Braſil to a Crimſon. And here it may be worth while to conſider, why Blew and Purple ſeem to bee deeper Colours than Red; and therefore the Juices of Plants of either of the two former Colours, may be turn'd red by Spirit of Salt, or *Aqua Fortis*; yet Syrup of Violets, ſhould be, on the contrary, turn'd green by Oyl of Tartar and Spirit of Urine, which is a more dilute Colour than Blew.

EXPERIMENT XXXVIII.

SALT diſtill'd, at a certain time of the Operation yields red Fumes; and Vitriol, tho green or blew, comes over in white Fumes; and the like I have obſerv'd in the Fumes of ſeveral other Concretes. And I have obſerv'd, that even Soot hath fill'd the Receiver with white Fumes; yet neither Spirit of Nitre is red, nor that of Vitriol or Soot white. And to theſe Obſervations we may add, that the Empyreumatical Oyls of Woods are of a Colour betwixt black and red: And tho' there is ſo great a difference in the Colours of Plants, yet the diſtilled Liquors vary not. And it is obſerv'd in Sublimation, that the Flowers differ much in Colour from the Fumes that compoſe them; as red *Benzoin* yields white Flowers, and Antimony affords Flowers ſome of them Red and ſome Grey; and ſome of them purely white. And it is the Practice of ſome Glaſs Men, to make a *Blew* ſublimate of a convenient Proportion of Brimſtone, *Sal Armoniack* and Quickſilver: And it is obſerv'd, that *Orpiment* which is a yellow Subſtance, yields a Sublimate, amongſt which, ſeveral red Fumes aſcend; and I have ſeen a Sublimate whoſe lower Parts were ſet with reddiſh Particles, which glitter'd prettily.

EXPERIMENT XXXIX.

IF good Spirit of Urine be dropp'd into a Tincture, or an Infuſion of the Flowers of Pomgranates, the Red will be turn'd into a Green Colour; but by Spirit of Sea-Salt, it will become

come a tranſparent Liquor, which red may be tur'd into a dirty Green, by Spirit of Urine.

Oyl of Tartar being dropp'd into Water wherein Leaves of *Senna* were immers'd, it preſently appear'd red; but the ſame would not happen upon an Affuſion of Oyl of Vitriol. Yet red Roſe Leaves being put in warm Water, Oyl of Vitriol extracted a red Tincture, but Oyl of Tartar would not. But we obſerv'd, that the Oyl of Tartar only haſten'd the Tincture of the *Senna*, ſince the Leaves in a Nights time will yield a Tincture in cold Water, which will not be heighten'd by Salt of Tartar. And it may be ſaid of the red Roſe Leaves, that the Tincture was rather extracted than produc'd by the Oyl: Yet this is obſervable, that in extracting the Tinctures, the one will not do what the other will; but I have found that *Aqua Fortis* will do as well as Oyl of Vitriol.

If upon the red Tincture of Roſes decanted, you drop Spirit of Urine, and ſhake the Viol it is contain'd in, it will acquire a greeniſh Blew; which is obſervable, ſince the turning of red into blew is a very unfrequent Obſervation. And in the Paſſage of this red Tincture to a blew, if it be taken as the Liquor is dropp'n in, it will afford a pretty variety of Colours, ſo as ſometimes to repreſent the Tincture of *Lignum Nephriticum*. And if the Tincture be very high, the Spirit of Urine will turn it to a deep Opacous blew; but the Liquor being left open two or three Days, both the blew and the red Colour vaniſh'd; the Liquor being of an Amber Colour, and having a feculent Sediment of the ſame Colour, which ſeems to be form'd of the Roſes

Roſes drawn together by the Acid, and precipitated by the Volatile Salt of the Spirit of Urine, in whoſe room other ſulphureous Salts may be ſubſtituted. And on this occaſion I ſhall add, That

Having dropp'd Spirit of Urine into an Infuſion of Galls, it preſently turn'd the Red Liquor into a Purple one; but if the Infuſion of Logwood were impregnated with acid Spirits of Salt, it would yield neither a Red nor a Purple, but a yellow Liquor.

EXPERIMENT XL.

TO ſhew that Colours may be generated *de novo*, and again deſtroy'd; We dropp'd Oyl of Tartar into a Solution of Sublimate in Water, and the Liquor being agitated, it was turn'd into a deep Orange Colour; but upon dropping in ſome Drops of Oyl of Vitriol, and continuing to ſhake the Glaſs ſtrongly, the whole will preſently become tranſparent again. In which the Colour reſults from a Coalition of the Mercurial Particles with the ſaline ones, and with the Alkalizate Particles of the Salt of Tartar, which ſwim up and down in the Oyl: But how theſe uniting come to form ſuch a Subſtance as reflects ſuch a Colour, I confeſs my ſelf at a loſs to explain. But in Confirmation of the Reaſon I have given for the Colour of this Precipitate; I ſhall add, that having ſublimed together equal Parts of *Sal Armoniack* and Sublimate, and diſſolv'd the aſcending Flowers in Water, and filtred it, the limpid Liquor turn'd white upon the Affuſion of an Alkaly, and not yellow.

And

And not only by altering the Texture of the Mercury, but by varying the precipitating Liquor, the Succeſs of the Experiment will be different: For if Spirit of Urine be made uſe of inſtead of Salt of Tartar, the Precipitate will be of a different Colour from the former. And from Quickſilver it ſelf, without Sublimate, we may prepare a Pricipitate, diſſoluble in Water without diſcolouring it. And the Colour of ſuch Subſtances ſo much depends on the Texture of the Parts concurring to the Compoſition, that tho' in our Experiment, Oyl of Vitriol deſtroys the yellow Colour; yet by the Aſſiſtance of Oyl of Vitriol, we may make a yellow Precipitate, with Quickſilver and Water alone. And I the rather employ Oyl of Vitriol in ſuch Experiments, becauſe it is not only void of Colour, but ſtrong and inciſive; for notwithſtanding common and undephlegmed *Aqua Fortis* will not effect the ſame thing; yet being carefully dephlegmed, it will in ſome meaſure anſwer Expectation. But one thing to be noted in this Experiment, is, That tho' by dropping in Oyl of Tartar and Oyl of Vitriol ſucceſſively, the Liquor will regain and loſe it's yellow Colour, yet the Proportion of the Liquor growing leſs in reſpect of the ſucceſſive additional Drops, the yellow Colour will gradually appear more faint.

An Improvement of the fortieth Experiment.

If Crude Antimony be boil'd in a ſtrong *Lixivium*, it will yield a ſulphureous Sediment, which will ſettle in yellow Flakes in the Bottom,

tom, and will be more apt to take fire than the Powder of Antimony. Therefore conſidering that Sulphur boil'd in a *Lixivium*, may be precipitated by Rheniſh or white Wine; and likewiſe that by Acids I could precipitate other ſulphureous Concretes out of lixiviate Solvents, ſuch as crude Antimony; And tho' common Sulphur yields a white Precipitate call'd *Lac Sulphuris*; yet I concluded that Antimony would yield a yellow one, as well by being made by Oyl of Vitriol, as Length of time. Wherefore I put a freſh Solution of Antimony into one Glaſs, and ſome of the Orange colour'd Mixture into another, where by dropping Oyl of Vitriol into the latter, it would become tranſparent, whereas the ſame Oyl would turn the other clear Solution into a deep Yellow. But in this Experiment we are to obſerve, that the Solution of Antimony muſt be freſh, otherwiſe in Winter it will ſcarce ſucceed.

Reflections on the XL Experiment *compar'd with the X and XX.*

Tho' the *X* and *XX Experiments* ſhew how Acids may be diſtinguiſh'd from Urinous and Alkalizate Salts; yet thence we cannot diſtinguiſh Urinous Salts from Alkalous. But by the Preceding Experiment I was enabled to diſtinguiſh Lixiviates by their precipitating an Orange Tawny, from a Solution of Sublimate in Water, whereas Urinous Salts would make it either White or Milky. So that by this Experiment I could diſcover, that *Sal Armoniack* drawn from an Alkaly, is but a Urinous Salt more refin'd, the

the Alkaly ſeparating, and retaining the Sea-Salt mix'd with it; for it would not only turn Syrup of Violets green, and Verdigreaſe Azure, but would precipitate a White Subſtance from a Solution of Sublimate. And from hence we may not only learn to conclude *Affirmatively*, but *Negatively* of the Nature of Salts, ſince Spirit of Wine and Eſſential Oyls have either no Salt in them, or it is of a peculiar kind, ſince they will neither turn Syrup of Violets Red nor Green, nor a Solution of Sublimate White or Yellow. I found that Spirit of Oak, tho' it be a Chymical Principle, yet it would turn Syrup of Violets Purple, and deſtroy the Blewneſs of a Tincture of *Lignum Nephritium*, as Acids do, and would corrode Coral like Spirit of Vinegar; but when the Acid Part of this Spirit was ſeparated from the other, it would have no more Effect upon any of thoſe Liquors as Spirit of Wine or Eſſential Oyls. And by this Method we may diſcover the Nature of moſt Salts produced either by Art or Nature; And by the ſame Method here laid down I have obſerv'd, ſeveral Liquors, which, tho' run *per Deliquium*, would have no other Effect than Spirit of Wine. And I know how to make a ſtrong ſaline Body, which will neither Work upon Syrup of Violets, or a Solution of Sublimate. And now to what I have ſaid, it may be ſeaſonable to add, that the Effects of Salts upon a Solution of Sublimate depend on the peculiar Texture, not only of the Solution, but of the Bodies by which it is precipitated; for a Solution of Gold in *Aqua Regia* will yield a yellow Precipitate, whether Oyl of Tartar, Spirit of Urine or *Sal Armoniack*

ack be added to it; yet Oyl of Vitriol, which precipitates a Solution of Silver in *Aqua Fortis* will have no ſuch Effect. And the Cryſtals of Silver diſſolv'd, will yield a White Precipitate; whether an Alkaly, or an Acid was dropp'd into the Solution, yet *Sal Armoniack* would not produce the like Effect: So that the Superfluous Moiſture being evaporated, the metalline Corpuſcles with the ſaline ones that had imbib'd them, coagulated into Salt, as ſuch Solutions uſually do, when the Metal hath been precipitated.

EXPERIMENT XLI.

AN Azure Solution of Copper in Spirit of Urine being ſhaken with Oyl of Vitriol, would become clear as Water. And tho' *Aqua Fortis* uſually extracts a Blew greeniſh Solution from *French* Verdigreaſe, yet being dropped into a Solution of it in Water, it almoſt render'd it Colourleſs; but upon an Affuſion of Oyl of Tartar or Spirit of Urine, it will diſcloſe a Colour ſomewhat different from the Solution of Verdigreaſe it ſelf.

EXPERIMENT XLII.

THE dry'd *Calx* remaining after an Evaporation of a Solution of Quickſilver in *Aq. Fortis*, gave a yellow Tincture; but Quickſilver being put into a Retort with four times it's Weight of Oyl of Vitriol, and the ſaline *Menſtruum* being drawn off in a Sand-heat, till a dry *Calx* remain'd in the Bottom, tho' this *Calx* was of a White Colour, it would paſs through

a Milky Colour to a Yellow upon an Affusion of Water. And *Beguinus*, *Tyr. Chym. Lib. 2. cap.* 13. Prepares *Turbith* Mineral, which he calls *Mercurius præcipitatus Optimus*, by digesting, and then two or three times Cohobating one Part of Quicksilver with two of Oyl of Sulphur, and by frequent Ablutions in hot distill'd Water, *&c.* But tho' this Yellow of ours be a much finer than any in the Painters Shops, yet it is too dear for ordinary use, were we certain it would agree with oyl'd Colours. From whence it appears, that a *Menstruum* which is devoid of Colour, may produce a Colour, being mix'd with a White *Calx*.

EXPERIMENT XLIII.

TO shew that a Colour may be produc'd by a Liquor that hath neither Colour nor saline Parts, we pour'd Water on a gray *Calx* of Vitriol, and tho' at the first the Mixture was of a muddy Colour, yet being shut up in a Viol for some days, the *Calx* being partly dissolv'd and shot into Vitriol, gave the Water a vitriolate Colour; and so it did to fresh Water pour'd on the *Calx*, when the tinged Liquor was decanted.

EXPERIMENT XLIV.

BY dropping a few Drops of a Tincture of *Cochinele* or *Brazil* into Water; it will acquire a Pink Colour; from which, by successive Additions, it will pass from that to a fine Red, and from that to a Crimson, and after that,

to

to an Opace Red; and ſeveral intermediate Colours may be perceiv'd in it's Paſſage from one Colour to another. But theſe variations will be more conſpicuous if we make uſe of cylindrical Pipes inſtead of Viols. And I have obſerv'd, that a Tincture of Brazil being put into a Viol, that in the Body of it appear'd Blew, but that in the Neck, which the Rays of Light trajected more plentifully, appeared green; and I had a Piece of Glaſs, which being held betwixt the Eye and the Light ſeem'd clear, and when the Eye was placed betwixt it and the Light, it appear'd ſlightly diſcolour'd; yet, being apply'd to the Glaſs it was knock'd off, it appear'd as green as Graſs. And I have had Bottles, which, tho' they were made of the ſame Materials with the Stopples, were nevertheleſs different in Colour. And I have a flat Glaſs, which obverted to the Eye flat, appears like ordinary Window Glaſs; but if the Edge of it be obverted to my Eye in a convenient Poſture, it will appear like an Emerald: And I have had a certain Pigment, which if it lay thick upon a Piece of Paper, would appear to be of a Crimſon, but being ſpread thin on the Paper, it would ſeem green. And I have likewiſe obſerv'd, that that blew Subſtance call'd *Litmaſe* being diſſolv'd in Water, gave it a Tincture betwixt Crimſon and Purple; yet it ſtain'd Paper Blew; and the like Colour was afforded by it on a Piece of flat glaz'd Earth. And ſome of the ſame being dropp'd into a Glaſs of Water of the Figure of an inverted Cone, exhibited great Varietys of Crimſon and Purple; and when the *Litmaſe* was perfectly mix'd with the Water

Water is afforded a glorious Yellow like that of a Topaz, when a few Drops of Spirit of Salt were dropp'd into it: And if a few Drops of a Solution of Pot-ashes were dropp'd into it, they subsiding into the bottom of it would afford a bright dilute Colour in the bottom of the Glass; a Purple above that, and a deep Crimson, betwixt that, and a Yellow, which rought to the top of the Glass: And if Spirit of Sal Armoniack were pour'd upon that it would turn Part of the Yellow into a Purple or Crimson. From which Experiments it appears, that as the Particles of a Pigment are nearer or more dispers'd, the Colours represented by them Vary.

EXPERIMENT XLV.

A Preparation of Steel, us'd as a Succedaneum of Spaw-Waters, and whose Colour was like that of *German Amethist*; being dropp'd into Rhenish-Wine afforded a lovely Green, but Water or Spirit of Wine will not receive that Tincture from it. And to satisfie my self that the Effect depended not on any Acidity in the Wine, I impregnated Water with Spirit of Salt, but notwithstanding, it would not receive a green Tincture from the Liquor. And to vary the Experiment, I dropp'd Alkalizate and urinous Salts into the Green Tincture, by which it put on a dirty and a turbid Colour, but if this essence of Steel was drop'd into Water impregnated with Spirit of Salt, a Solution of Salt of Pot-ashes or of Spirit of Sal Armonick

would turn it Yellow, the Vitriolate Salt being precipitated by them: And *Olaus Wormius* takes Notice of a rare kind of Turn-sole, which would communicate a red Tincture to Water; and tho' it would to Wine, yet Spirit of Wine would not be at all Ting'd by it, so that Tincture both depends on the peculiar Textures of the Body that receives and that which gives the Tincture.

EXPERIMENT XLVI.

THe Adventitious Colours of Metals are either such as they acquire by the Action of the Fire upon them; or such as result from the Coalition of Metaline Particles with the Mestruum which dissolves them; or lastly when they are mix'd together by Fusion.

And first Tin, by the Action of the Fire being calcin'd, affords a white Calx and Lead a Red one; and Copper calcin'd *per se*, yields a dark blackish Powder; and Iron by reverberated Flames may be turn'd into a Crocus, and Mercury may be turn'd into a Red Powder. And,

Besides these more obvious Colours there are several intermediate ones, whilst by the Action of Fire, Metals are a Calcining. And not only the Calces, but the Glasses of Minerals vitrifi'd *per se* are of Colours different from the Metal; so that I have seen a Glass made of Silver, of a dark Colour.

And not only Metals, but Minerals may be brought to yeild Colours, by the Action of the Fire, different from their own, as Antimony affords

affords a whitiſh Gray Calx, and Flowers variouſly Colour'd; and the *Calx* by being flux'd will yield a Glaſs of a yellow or reddiſh Colour. And Vitriol Calcin'd paſſes through ſeveral Colours before it comes to be of a dark Purple.

EXPERIMENT XLVII.

AS for the Adventitious Colours produc'd by the Union of Metals with their Solvents; Gold gives *Aqua Regis* it's Yellow Colour, but Mercury gives no conſiderable Colour to *Aqua Fortis*, except a Greenneſs or Blewneſs at the firſt, which preſently diſappears. Tin corroded by *Aqua Fortis*, ſubſided in the form of curdl'd Milk or Eggs. Lead diſſolv'd in Spirit of Vinegar, affords a clear Solution; and if the Menſtruum be drawn off, appears White. Iron diſſolv'd by Oyl of Vitriol diluted with Water, yields a Green *Vitriolum Martis*; but gives a Saffron Colour to *Aqua Fortis*, or a yellowiſh Red. Common Silver, ſuch as is coin'd, gives a Copper Tincture to *Aqua fortis*; but ſuch as is refin'd perfectly, gives a blewiſh Green to *Aqua fortis*, and Spirit of Vinegar; and being ſublim'd with Sal Armoniac, it affords a blewiſh Sublimate. And indeed Copper diſſolv'd in ſeveral Menſtruums will yield a great Variety of Greeniſh Blew or blewiſh Green Colours. But with Spirit of Sugar and Turpentine it affords a Blew Tincture with a mixture of Green. And to ſhew that the Adventitious Colour may reſult from the Copper it ſelf as well as the Salts which Corrode it, I moiſtned

would turn it Yellow, the Vitriolate Salt being precipitated by them: And *Olaus Wormius* takes Notice of a rare kind of Turn-sole, which would communicate a red Tincture to Water; and tho' it would to Wine, yet Spirit of Wine would not be at all Ting'd by it, so that Tincture both depends on the peculiar Textures of the Body that receives and that which gives the Tincture.

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Besides these more obvious Colours there are several intermediate ones, whilst by the Action of Fire, Metals are a Calcining. And not only the Calces, but the Glasses of Minerals vitrifi'd *per se* are of Colours different from the Metal; so that I have seen a Glass made of Silver, of a dark Colour.

And not only Metals, but Minerals may be brought to yeild Colours, by the Action of the Fire, different from their own, as Antimony affords

affords a whitish Gray Calx, and Flowers variously Colour'd; and the *Calx* by being flux'd will yield a Glass of a yellow or reddish Colour. And Vitriol Calcin'd passes through several Colours before it comes to be of a dark Purple.

EXPERIMENT XLVII.

AS for the Adventitious Colours produc'd by the Union of Metals with their Solvents; Gold gives *Aqua Regis* it's Yellow Colour, but Mercury gives no considerable Colour to *Aqua Fortis*, except a Greenness or Blewness at the first, which presently disappears. Tin corroded by *Aqua Fortis*, subsided in the form of curdl'd Milk or Eggs. Lead dissolv'd in Spirit of Vinegar, affords a clear Solution; and if the Menstruum be drawn off, appears White. Iron dissolv'd by Oyl of Vitriol diluted with Water, yields a Green *Vitriolum Martis*; but gives a Saffron Colour to *Aqua Fortis*, or a yellowish Red. Common Silver, such as is coin'd, gives a Copper Tincture to *Aqua fortis*; but such as is refin'd perfectly, gives a blewish Green to *Aqua fortis*, and Spirit of Vinegar; and being sublim'd with Sal Armoniac, it affords a blewish Sublimate. And indeed Copper dissolv'd in several Menstruums will yield a great Variety of Greenish Blew or blewish Green Colours. But with Spirit of Sugar and Turpentine it affords a Blew Tincture with a mixture of Green. And to shew that the Adventitious Colour may result from the Copper it self as well as the Salts which Corrode it, I moistned

Dantzick Vitriol with Spittle, and then rubbing it upon a Knife, it gave it a rediſh Colour like that of Copper. *Saccharum Saturni* with Spirit of Turpentine will yield a red Balſam; and that Stone which *Helmont* calls *Paracelſus* his *Ludus*, in a proper *Menſtruum* affords ſometimes a yellowiſh and ſometimes a red Solution.

And before I leave this Experiment I ſhall add that if Quickſilver be precipitated out of *Aqua fortis* with Spirit of Sea-ſalt, or Sea-ſalt diſſolv'd in Water, it will ſubſide in the form of a white Powder; but if it be precipitated with an Alkaly it yields a yellow tawny Powder; but if the *Menſtruum* be drawn off without precipitating it, the remaining ſubſtance, will vary it's Colour, as it is expos'd to different degrees of Heat; ſo that once I obſerv'd the white Calx, to remain partly in the bottom of the Vial, of a deep Yellow, and in ſome part Red, the remaining Part being elevated in the form of a reddiſh and aſh-colour'd Sublimate. And Vermilion, is only a Sublimate of Mercury and Brimſtone.

EXPERIMENT XLVIII.

TO ſhew that Metals Aſſociated with other Bodies will afford different Colours, I have given an Inſtance in Silver, which gave Glaſs a lovely golden Colour. And I ſhall now add, that I am told, that Artificers paint Glaſs yellow with *Calx* of Silver. And I have obtain'd a Subſtance of a ſaphirine Blew from Shel-ſilver mix'd with Powder of cryſtal Glaſs, kept in Fuſion two or three Hours, which I attributed

attributed to ſome Copper latent in the Silver. And tho' Copper calcin'd *per ſe* yields a dark colour'd *Calx*, yet it tinges Glaſs Green; But being kept in Fuſion with 100 times it's Weight in Glaſs, it afforded not a green, but a blew Subſtance, which whether it proceeded from the Action of the Mineral, or it's ſaline Parts only, or both, I muſt not ſtay to enquire. But to proceed, Putty made of Tin and Lead Calcin'd together, being a white *Calx* gives colliquated Glaſs the reſemblance of white Amel, which will receive into it the Colours of divers Minerals which will indure the Fire: And I have elſewhere taken Notice, that blew and yellow Amel, being compounded will afford a Green. And it is commonly known that the dark Subſtance call'd *Zaffora* will give Glaſs a blew Tincture. And that dark Subſtance term'd *Magneſia* from it's ſimilar Colour to that of a Load-ſtone, gives Glaſs not only Colours different from its own, but in themſelves; as a Red, Purpliſh or Blackiſh, as the Quantity of it varies; yet it is us'd to free Glaſs from that blewiſh green Colour that it is ſubject to; and this may ſerve to confirm what we deliver'd in the XLIV Experiment, *viz.* that as the Parts of a Pigment are more cloſely or ſet at diſtance, the Colour will vary. And here it may not be altogether fruitleſs to adverтiſe, that it may be a good way of trying Ores, and what Metal they moſt abound with, to try what Colour they give Glaſs, when mix'd in a due proportion, and kept in Fuſion in an equal Degree of Heat and length of time.

But to proceed to other Inſtances agreeable to thoſe we have laid down, yellow Orpiment and Sea-ſalt Sublim'd together conſtitute white Arſnick, and tho' Orpiment is the greater Part of the Compoſition; yet Arſenick gives Copper a white Colour within and without.

In counterfeiting Factitious Gems by Vitrification, it is obſerv'd, That calcin'd Lead, Colliquated with white Sand, or Cryſtal powder'd by ſucceſſive Ignitions and extinctions, yields a Decoction, of the Colour of a *German Amethiſt*: And I have obſerv'd, in calcin'd Lead it ſelf, ſomething like the Colour of ſuch an *Amethiſt*: And with Glaſs of Lead overpower'd with other Pigments, you may emulate the Greenneſs of Emeralds, tho' in ſeveral Caſes, the Colour of the Lead may vitiate that of the Pigment; and theſe Colours ſo much depend upon Texture, that before the aforemention'd Mixture acquir'd an *Amethiſtine* Colour, it paſſed through ſeveral intermediate Colours; and the Colours of ſuch Subſtances may be ſo much vary'd by degrees of Fire, that I have had, a Maſs of the ſize of a ſmall Nut, of four diſtinct Colours.

ANNOTATIONS.

BUt beſides the aformention'd Ways by which Metals may acquire adventitious Colours, there are yet two unmention'd. For I am told, that it is impoſſible to ſtrike that Colour term'd a *Bow-dye* without the Materials be boyl'd in Veſſels, either made of, or lin'd with a Particular Metal.

The

The other way of dying Bodies, is with the Solution of Metals in their proper *Menſtruums*; ſo Gold diſſolv'd in *Aqua Regis*, will dye the Nails and Skin, and Hafts of Knives made of Ivory, not with a Golden Colour, but a Purple, ſcarce ever to be waſh'd out: And I have already told you, that a Solution of Silver will dye the Nails Black. So Brine colours Beef Green or Red, and a certain proportion of Salt-Petre and common Salt Colours Neats Tongues Red, and ſuch Fleſh as would be otherwiſe White. And to theſe I ſhall add, that a Solution of Sulphur of Vitriol or common Sulphur, will Colour Silver with a golden or reddiſh Colour, for which Reaſon the *Bath* Water cauſes that Effect. And the Juice of *Alcanna*, which is Green, dyes the Skin and Nails of a laſting Red.

EXPERIMENT XLIX.

BOyl a ſufficient Quantity of powder'd Turmerick with Water, adding to every pound of Water, two Spoonsful of a filtred Solution of Pot-aſhes, in a clean glaz'd Veſſel, till by immerſing a Piece of Paper, you find the Turmerick to have given it's Tincture; then drop into the filter'd Tincture a Solution of Roach Allom, the ting'd Parts being curdl'd, will ſwim up and down in Flakes, and the Liquor will paſs through a Filtre clear, leaving the Yellow Parts behind it, which may be dulcifi'd by an Affuſion of Water, but this vegetable Lake may be ſeperated from the decanted Liquor without filtration by pouring

on a ſufficient Quantity of Water; for then it will either ſwim on the Top or ſubſide to the Bottom, and may be made fit for uſe by being dulcifi'd with freſh Water, after it hath been gather'd by Filtration, and then it muſt be dry'd upon a Cloth, under which Bricks Chalk or Paper, is plac'd to imbibe the Moiſture.

ANNOTATIONS.

THo' it be generally believ'd, that this Magiſtracy of Vegetables is only made up of the colour'd Parts of the Plants, yet to favour the contrary I ſhall repreſent that Allom contains a ſtony Matter as well as an Acid Spirit; and tho' Workmen in the making of it uſe a Sea Weed (call'd *Kelp*) and Urine, yet natural Allom hath been found in *England*, a Solution of which, by an Affuſion of *Lixivium* of Potaſhes would depoſe a white Curd, which being filtred would leave behind it a metalline ſtony *Calx*, very White, little Bits of which, being plac'd upon a live Coal, would neither melt nor fly away, nor would they waſh away in hot Water, ſo that they were unlikely to be ſeperated from the Vegetable Lake by Ablutions. And to this I ſhall add, that from the filtred Liquor I have obtain'd ſaline Parts, which would Flame at a Candle, and fly away with ſome Noiſe; and I have obtain'd ſuch a Subſtance from Allom by precipitating it with urinous Salts and even Urine it ſelf; ſo that ſometimes we may think, that we obtain a Precipitate

cipitate from a Liquor, when it is in a great measure yielded by the Solution of Allom made use of to precipitate it.

The abovemention'd way of making Lakes, being try'd with Madder, it yielded a Red one, and with Rue, it afforded one of the same Colour with the Leaves. But since the Colour is extracted from the Vegetable by the addition of a *Lixivium*, it is a Question, whether the Lake will always be of the Colour of the Herb, since *Lixiviate* Salts may not only extract, but alter the Tinctures of Vegetables. And tho', Acids sometimes do, yet we have found by experience, that they will not always restore Colours destroy'd by Alkalies, since Syrup of Violets turn'd Green by an Alkaly, will not be restor'd to a Blew by an Acid, but is chang'd to a Red. And I have found, that when the Colour of the Lake was not alter'd by the Alkaly, it would be much fainter than the Vegetable it was drawn from. But to conclude this Experiment, I shall add, that Allom is not only of use in such like Experiments as these; but also in the Dyers Trade.

EXPERIMENT L.

HAving a Mind not only to change the Colour of one Body into another, but also to obtain two Substances of distinct Colours from one Body; in order to it I consider'd, that since Spirit of Vinegar wholly loses it's Acidity by working upon *Minium*, the Solution would alter the Juices of Plants, as Oyl of Tartar usually does, and

and accordingly I found that it turn'd, an Infuſion of red Roſe Leaves Green. And further conſidering, that Oyl of Vitriol will precipitate Solutions of Minerals, eſpecially in Spirit of Vinegar, and that the Calcesare uſually fair and White:

Conſidering theſe things, I dropp'd a Solution of *Minium* into an Infuſion of Roſes, by which it was turn'd Green; but dropping on that Oyl of Vitriol, it would precipitate the Lead in the form of a white Powder, and leave in the Liquor a clear and high Tincture of Roſes, which appear'd when the Experiment was try'd in a Glaſs ſhap'd like an inverted Cone. And this Experiment likewiſe ſucceeded, when Spirit of Salt was made uſe of inſtead of Oyl of Vitriol; but with *Aqua Fortis* it would not ſucceed; for tho' that Liquor will heighten the Colour of the Tincture of Roſes, yet it will not precipitate the Lead.

And as by this means from a Green we obtain'd a white and red colour'd Subſtance, ſo a Purple will yield a yellow and a red Liquor; for if inſtead of an Alkaly, which turns an Infuſion of Logwood Purple, I made uſe of a Solution of *Minium*, and put one Part of this to two of the Infuſion, Spirit of Salt would precipitate a red Subſtance and leave the Liquor above Yellow. But an Infuſion of Logwood being turn'd Purple by a Mixture of a Solution of *Minium*, Spirit *Sal Armoniack* dropped upon them, precipitated a Blewiſh deep Purple Subſtance, partly in the form of a Powder and partly Curdl'd; but upon an addition of Spirit of Salt the remaining Part of the

the Lead was precipitated in the form of a white Powder; ſo that there were in the Glaſs three diſtinct Colours, *viz.* a Purple at the bottom, a white Carnation upon that, and upon the top a tranſparent Liquor, Yellow or Red.

But to conclude, I ſhall add that I would not have my Readers too haſtily to think any of the foregoing Experiments falſe, tho' they ſhould not ſucceed upon firſt Tryal, ſince very ſlight Circumſtances may alter or fruſtrate the Event of ſeveral of them; to Confirm which I ſhall add the following Inſtance, *viz.* that if the Ingredients made uſe of to dye Scarlet, be weighed and mix'd never ſo exactly, and all other circumſtances be obſerv'd; yet if they are not boyled in a Veſſel lin'd with Tin, the Cochineel will not be able to ſtrike a right Colour.

FINIS.

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